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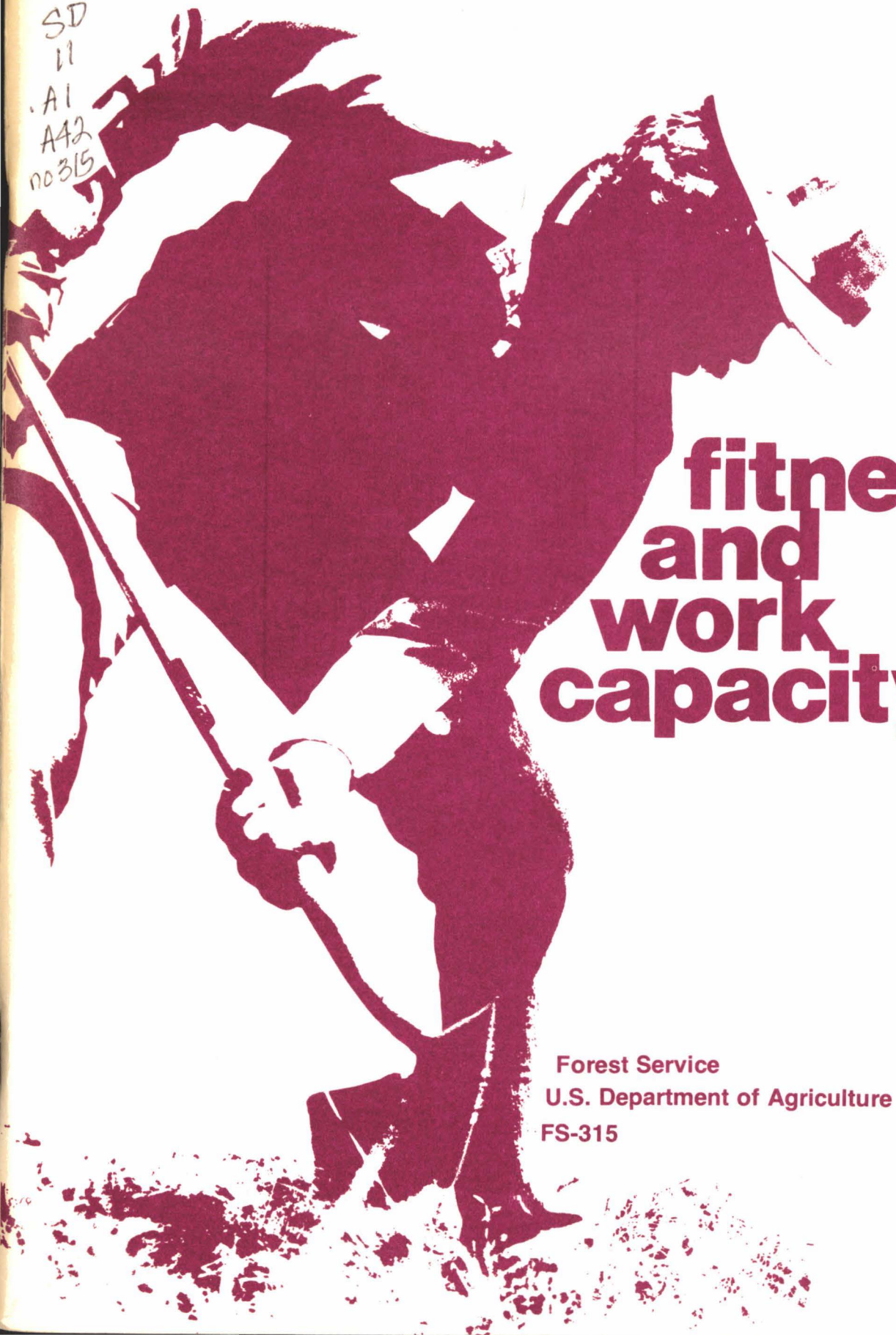
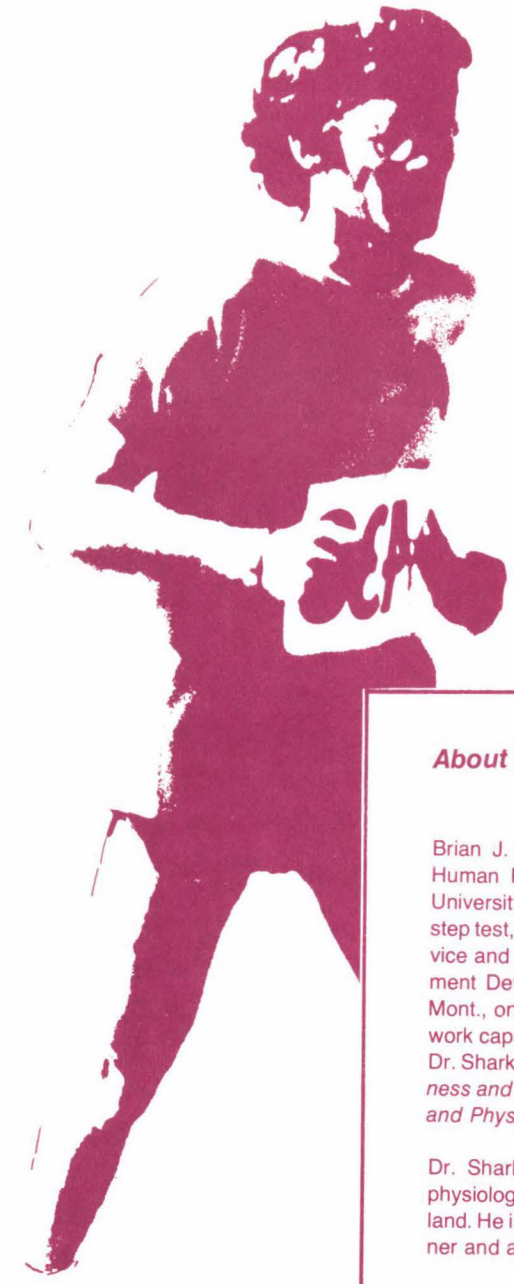


fitness and work capacity

Forest Service
U.S. Department of Agriculture
FS-315



About the Author

Brian J. Sharkey is the director of the Human Performance Laboratory at the University of Montana. He developed the step test, a fitness test, for the Forest Service and works with the agency's Equipment Development Center at Missoula, Mont., on subjects related to fitness and work capacity. In addition to this booklet, Dr. Sharkey has written *Physiological Fitness and Weight Control* and *Physiology and Physical Activity*.

Dr. Sharkey holds a Ph.D. in exercise physiology from the University of Maryland. He is a dedicated long-distance runner and an avid tennis player and skier.

fitness and work capacity

by Brian J. Sharkey

May 1977

Forest Service
U.S. Department of Agriculture

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402

Price $2.20; 25% discount allowed on orders of 100 or more to one address

Stock No. 001-001-00426-0

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

Washington, D. C. 20250

September 1, 1976

People are the most important resource in any agency or business. Goals and objectives will be met only to the extent that employees are able to perform according to their abilities on and off the job. I am convinced that mental and physical health and well being determine the level of accomplishment for any individual.

This book, Fitness and Work Capacity, contains the basic information you need to maintain a physical fitness level which will meet your personal expectations and the needs of your job. It explains how you can measure your physical fitness level, and prescribes a safe and practical conditioning program which can become part of your life.

I highly recommend it to you, your family, and associates. The benefits to the organization are well recognized. Most important, it could be the doorway to a healthier, more productive, and satisfying life for you.

John R. McGuire

JOHN R. McGUIRE
Chief

THE PRESIDENT'S COUNCIL ON PHYSICAL FITNESS AND SPORTS
WASHINGTON, D.C. 20201

September 1, 1976

The President's Council on Physical Fitness and Sports has, for many years, supported the importance of regular physical exercise in promoting employee health and safety. Recently it has become increasingly apparent that physical fitness significantly reduces both human and financial losses suffered by business, industry, and government. This relationship is particularly significant among emergency service personnel.

Therefore, we are especially pleased to endorse the Fitness and Work Capacity booklet which brings to light the relationship between physical fitness and work capacity. Having carefully reviewed the contents of this publication, I feel that it makes a valuable contribution to the physical fitness effort. It clearly demonstrates the advantages derived from participating in regular exercise, not only for the employee but also for the organization which he serves.

Sincerely yours,

C. Carson Conrad

C. Carson Conrad
Executive Director

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Introduction

For centuries the primary source of power was derived from the contractions of human and animal muscles. While the clever use of wind and water augmented muscular power, it was not until the 18th century that mechanization began to reduce the need for muscular work. Machines were devised to supplement or replace human effort, and today, when men and women go to "work," few are required to engage in arduous muscular effort. A host of labor-saving devices has eliminated the need for muscular work at home. And the automobile has made getting from place to place physically effortless.

We are now witnessing the consequences of this trend – the average worker is incapable of delivering a full day's effort in a physically demanding job, and degenerative diseases associated with inactivity, such as heart disease – the Nation's number one killer – are on the rise.

Many jobs, forestry fieldwork is one example, still require strength and endurance – at least part of the time. People desk-bound much of the year often must engage in strenuous fieldwork in summer. Without proper conditioning, the stress of physical work can be unpleasant or worse.

Concern for employee safety and health has prompted screening procedures to make sure only the fit are assigned arduous field tasks. Unfit persons can quickly become a hazard to themselves and to their coworkers. Studies have shown that fit workers are safer and more productive than their sedentary colleagues. The relationship of fitness and work capacity is clear. Employers recognize that fit employees are good business. In 1975, 50,000 U.S. companies spent an estimated $2 billion in fitness and recreational programs for their employees.

But little has been written about the relationship of fitness to work capacity, until now. This booklet fulfills that need for forestry fieldwork by explaining the fitness required for such jobs. The booklet is based on actual research and data collected in the field and makes clear the importance of fitness to your job.

So if your job requires fieldwork, if you'd like to qualify for field assignments, or you're just concerned about good health, you owe it to yourself to get in shape.

The purpose of this booklet is to help you do just that. Reading it will give you a good understanding of fitness and its relationship to work capacity.

Let me clarify what I mean by fitness and work capacity: *Fitness* is the ability to carry out daily tasks with vigor and alertness, and with ample energy to enjoy leisure-time pursuits and to meet unforeseen emergencies. *Work capacity* is the capability to accomplish production goals safely and without undue fatigue.

Understanding fitness is just part of our purpose. Achieving fitness is another. I'll explain how to assess your current level of fitness, then suggest specific steps you can take to achieve whatever fitness goals and work capacity standards you may choose for yourself.

But fitness is more than increased work capacity or improved safety on the job. It means better health and vitality, less risk of heart disease, a trim, pleasing appearance, and more energy. It enhances the quality of life by making an active lifestyle possible. It's the best investment you can make toward those retirement years.

I hope this booklet will encourage you to seek the benefits of fitness. And remember:

FITNESS CAN NEITHER BE BOUGHT NOR BESTOWED
LIKE HONOR IT MUST BE EARNED

aerobic fitness and work capacity

1

Fitness means many things to many people. The physician may view fitness as the absence of disease. The body-builder may consider it well-developed muscles, while the young woman may think it's a curvaceous figure. The coach defines fitness as those factors related to success in sports, and the physical educator looks for strength, endurance, flexibility, speed, agility.

For our purposes, fitness is primarily a well-developed oxygen delivery system – strong heart and lungs that efficiently deliver oxygen to the working muscles. We call this *aerobic* fitness because metabolism in the presence of oxygen is termed aerobic. Your maximum ability to take in, transport, and use oxygen is the best single measure of fitness and work capacity.

MAXIMUM OXYGEN INTAKE = AEROBIC CAPACITY

- Distinguish aerobic fitness from other common uses of the term fitness.
- Understand the relationship of aerobic fitness to work capacity.
- List documented benefits of aerobic fitness.

Fitness and Work Capacity

The connection between aerobic fitness and work capacity is a direct one. The body requires energy to perform work, energy created by burning fats and carbohydrates. This process takes oxygen. The tougher the job, the more energy – and oxygen – needed.

Aerobic fitness is typically measured in a laboratory treadmill test. No other measure tells so much about your heart, respiration, muscles; no other measure tells so much about your work capacity.

For this reason, the Forest Service and some Department of the Interior agencies adopted a 5-minute step test in 1975 to predict the maximum aerobic fitness of their workers and to screen people for wildland firefighting jobs. The step test is an inexpensive alternative to treadmill testing in the laboratory.

Test results are standardized in milliliters (ml) of oxygen consumed per kilogram (kg) of body weight per minute (min), the common measurement of aerobic fitness. Test scores indicate your level of aerobic fitness and allow reasonably accurate predictions of work capacity. A score of 45 (ml/kg/min) or better is required for arduous fireline work.

About the Step Test . . .

Federal agencies have adopted a 5-minute step test to screen people for wildland firefighting jobs. The purpose of this physical fitness test is to make sure those given arduous firefighting tasks can do their jobs safely and well.

The test predicts a person's ability to take in, transport, and use oxygen (aerobic fitness), the most important factor limiting the ability to perform arduous work. Field performance relates directly to how well the body delivers oxygen. The body cannot store oxygen, so working muscles, which need a continuous supply to perform vigorous day-long work, require an efficient oxygen intake and delivery system.

This ability can be measured in the laboratory on treadmills and bicycles. But lab testing is costly and time consuming, so it is unsuited for testing large numbers of people. For that reason, the step test was selected because it is easy to administer and inexpensive. The 5-minute step test was developed in 1954 by Swedish physiologists.

The test underwent field trials to see if it differentiated levels of fitness, and additional data were collected in lab studies to validate test scores. The step test proved accurate and easy to give. Most important, taking it doesn't tax older or unfit persons unnecessarily. The test is moderately strenuous, but far less than a full day in the field can be.

A system of scoring test results was developed that rates fitness numerically, based on post-exercise pulse rate, body weight, and age. Your capacity to take in, transport, and use oxygen is expressed in milliliters of oxygen consumed per kilogram of body weight per minute. By expressing the score this way, individuals of differing body size can be compared.

Your test score – aerobic fitness score – indicates fitness for various types of fieldwork. Firefighting jobs have been assigned fitness scores ranging from 45 for fireline building and other strenuous work to 35 for jobs involving less effort. To qualify for these positions, applicants must attain the necessary test score.

The test itself is simple. It entails stepping on and off a bench (15¾ inches high for men, 13 inches high for women) in time to the beat of a metronome set at 90 beats a minute. After 5 minutes of exercise, pulse is taken at wrist or throat for 15 seconds, beginning *exactly* 15 seconds after the test ends. Fitness scores are computed based on post-exercise pulse rate, body weight, and age. A special calculator is used to figure fitness scores. The calculator is sold by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 for 80 cents (stock no. 001-001-00404-9). The calculator contains directions for taking the step test and a list of the equipment needed.

On jobs where oxygen and energy needs are low – office work is a good example – performance isn't as related to fitness. But wildfires and other strenuous field assignments demand much oxygen and energy, and the amount of work done relates directly to the ability to produce energy aerobically. Unfit individuals may be able to work at only 25 percent of their aerobic fitness level for prolonged periods, while the highly fit may work at 50 percent of their maximum for long periods. The fit worker is able to sustain a higher work rate than the unfit.

Studies by the Forest Service Equipment Development Center, Missoula, Mont., indicate that the oxygen and energy demands of firefighting average about 22.5 ml/kg/min. Since workers can't sustain more than 50 percent of their maximum aerobic capacity for an 8-hour shift, they should have an aerobic capacity *two* times the energy demands of the job:

22.5 x 2 = 45 ml/kg/min
fitness for firefighting

The 22.5 ml/kg/min is an average. Many firefighting tasks demand more oxygen and energy, some less. Working with a pulaski costs 22.3 ml/kg/min; a shovel, 22.9; other tools from 20 to 30 ml/kg/min. Hiking in mountainous terrain can consume from 14 to 28 ml/kg/min, depending on the hiking rate, steepness of slope, and other factors.

But perhaps you have a desk job and never expect to do strenuous fieldwork or fight a forest fire. Will aerobic fitness help you? Well, aside from the health benefits, which I'll discuss next, here's how fitness can benefit the office worker:

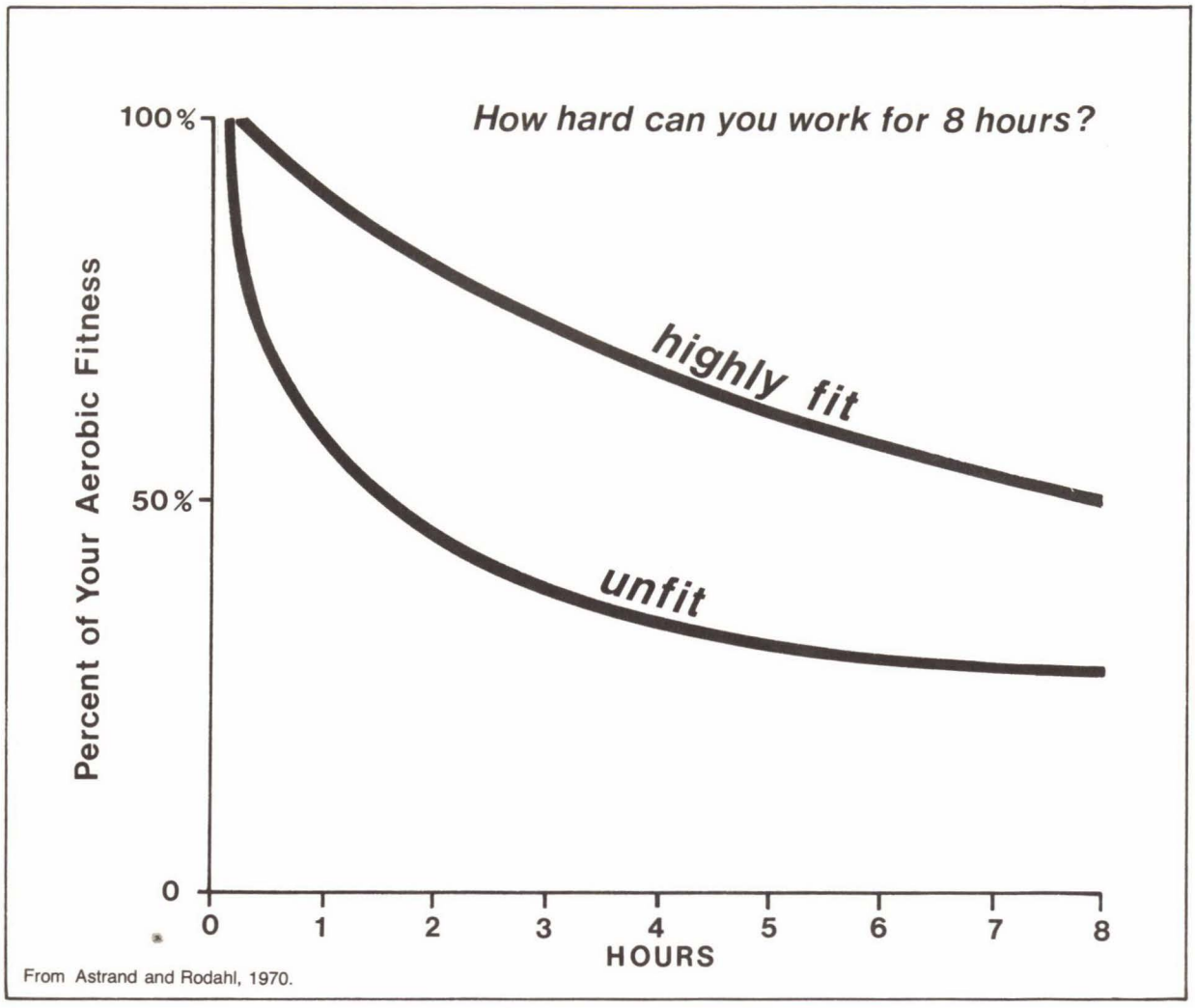
Muscles burn carbohydrate (sugar) or fat for energy. The brain and nervous system depend on blood sugar for energy. Unfit individuals tend to use more sugar for a given task than do the fit. As you train for fitness, you become better able to fuel working muscles with fat, thus conserving limited sugar supplies for the brain. With more blood sugar available, you're less likely to tire, either on the job or off. Your mind is sharper; you work better.

Ask yourself these questions:

- Do I tire during the workday?
- Am I tired at the end of the workday?
- Do I have energy left over after work for hobbies or other leisure-time pursuits?
- Do I have the energy for weekend chores and some left over for fun?

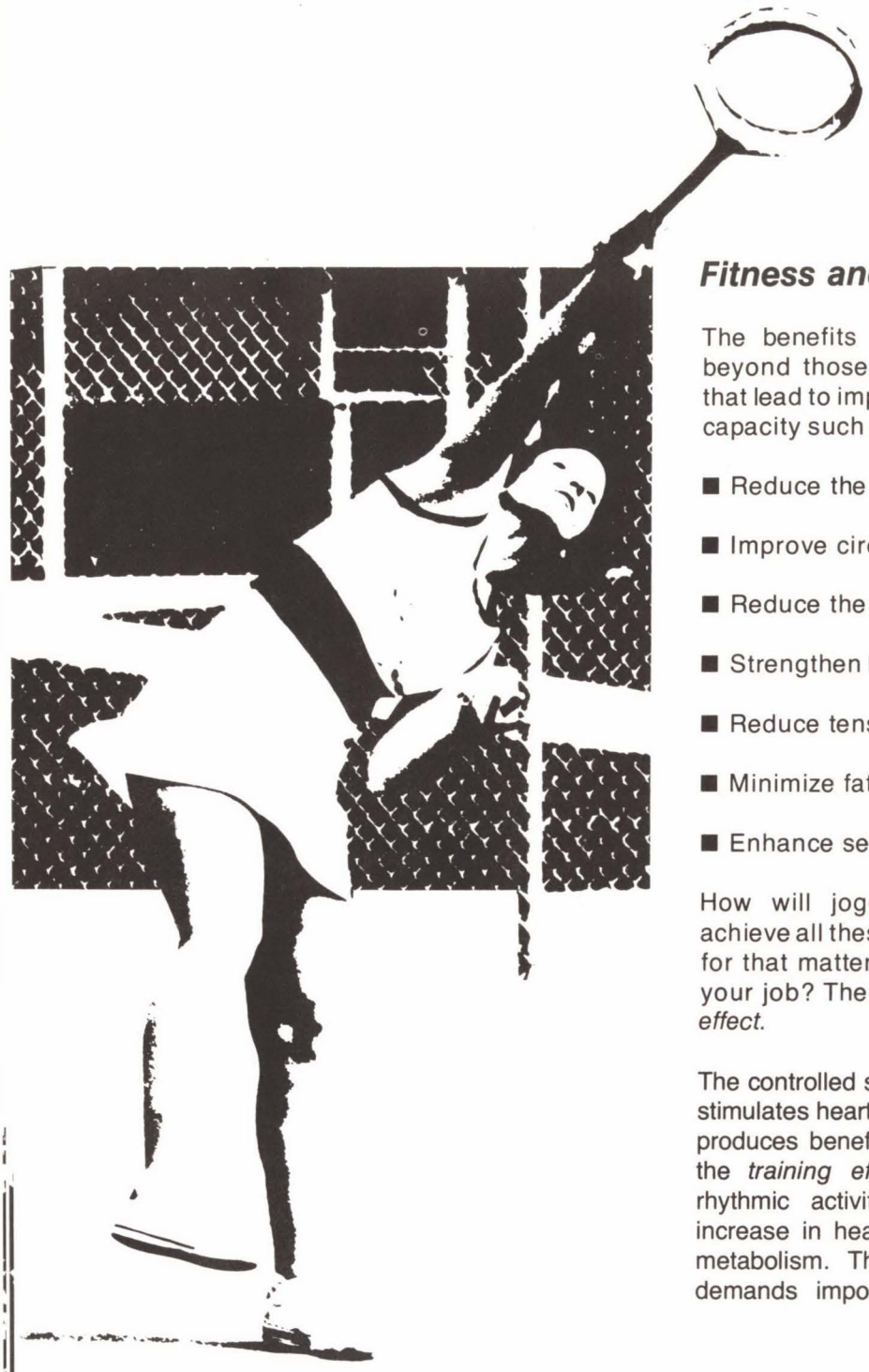
If you seem to tire easily without good reason, if you seem to need a lot of naps, if you lack the energy to join the kids in an active game, consider the benefits of aerobic fitness.

FIT PEOPLE MISS FEWER DAYS OF WORK



From Astrand and Rodahl, 1970.

"Unfit individuals may be able to work at only 25 percent of their aerobic fitness level for prolonged periods, while the highly fit may work at 50 percent of their maximum for long periods. The fit worker is able to sustain a higher work rate than the unfit."



Fitness and Health

The benefits of aerobic fitness extend far beyond those related to your job. Activities that lead to improved aerobic fitness and work capacity such as jogging and swimming also:

- Reduce the risk of heart disease.
- Improve circulation and respiration.
- Reduce the problems of overweight.
- Strengthen bones, ligaments, and tendons.
- Reduce tension and psychological stress.
- Minimize fatigue.
- Enhance self-concept and body image.

How will jogging or swimming help you achieve all these good things for your body, or for that matter make you more productive at your job? The answer is found in the *training effect.*

The controlled stress of regular aerobic exercise stimulates heart, lung, and muscle activity, which produces beneficial changes in the body called the *training effect.* Aerobic exercise is any rhythmic activity that promotes a sustained increase in heart rate, respiration, and muscle metabolism. The body adapts to the added demands imposed by this kind of exercise.

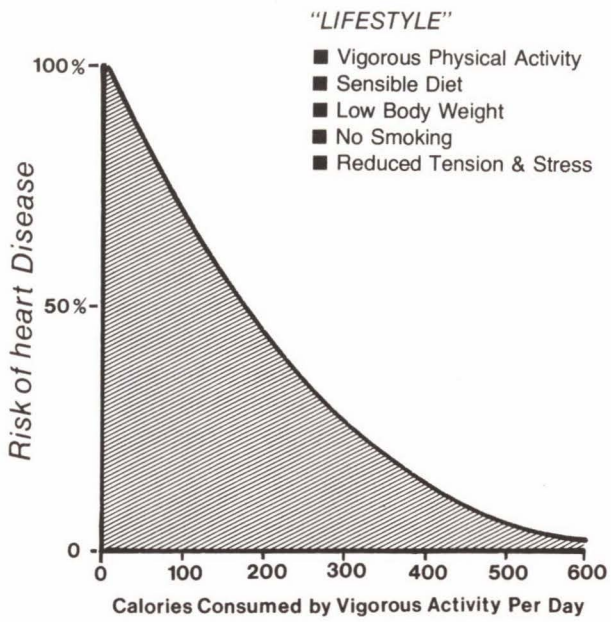
Adaptions include improved heart and lung function, improved muscular endurance. These and other adaptations lead to improved health and vitality.

The heart is a muscle. Exercise strengthens it, making it a more efficient pump. The heart of the unconditioned person, for example, may eject only 70 percent of the blood in each chamber. Ejection may improve to 80 or 90 percent in the conditioned person; so the heart will beat less often. This allows the heart to get more rest between beats. Exercise reduces the total work done by the heart.

Unconditioned: heart rate = 70 beats a minute x 60 minutes an hour x 24 hours = *100,800* beats a day

Conditioned: heart rate = 50 beats a minute x 60 minutes an hour x 24 hours = *72,000* beats a day

As physical activity increases, the risk of heart disease declines. Dr. Thomas Bassler of the American Medical Joggers Association, a group of runner-doctors, believes that runs of 6 miles or more a day may give the runner virtual immunity from heart disease. Proper diet, weight control, no smoking or smoky rooms, and reduced tension and stress also are factors in preventing heart disease. So your livestyle may be as important as physical activity.



"As physical activity increases, the risk of heart disease declines. So your lifestyle may be as important as physical activity in preventing heart disease."

Respiratory muscles become more efficient, too. Fit individuals take in more air per breath, breathe deeper, and ventilate a greater proportion of their lungs, getting more oxygen into the blood. Oxygen transport in the blood is improved by an increase in hemoglobin and total blood volume.

The body learns to better distribute the blood to working muscles. This redistribution, accompanied by increased heart output, leads to an improved supply of oxygen to the working muscles. Aerobic exercise may increase the number of capillaries serving individual muscle fibers.

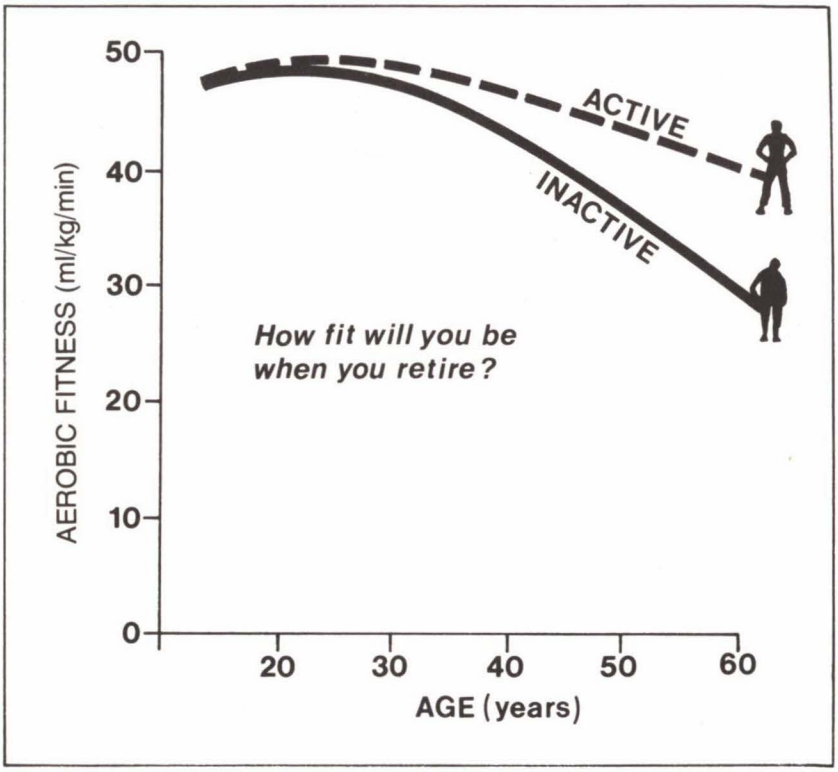
Muscles undergo specific adjustments that enhance their ability to take in and use oxygen to burn the food you eat, producing the energy for continued muscular contractions.

Aerobic exercise influences other organs and systems: The nervous system learns to use muscles efficiently; the endocrine system learns to support your efforts with the appropriate hormones. Bones, ligaments, and tendons get tougher.

The physique and body composition can be altered. Body fat diminishes, muscles tone up, and appearance improves. Along with improved appearance and the feeling of well being go some subtle psychological changes: improved self-concept and body image, reduced anxiety, improved vitality, increased self-confidence, and joy of living.

There is evidence that some of the effects of aging may be temporarily offset with a vigorous aerobic fitness program, so the increased capacity and adaptability associated with aerobic fitness can add life to your years, not just years to your life.

AEROBIC FITNESS EXTENDS THE PRIME OF LIFE



"There is evidence that the effects of aging may be temporarily offset with a vigorous aerobic fitness program."

aerobic fitness prescriptions 2

The benefits of fitness are achieved through regular aerobic exercise. Like any treatment or medicine, exercise must be prescribed with care if its benefits are to be realized, and if its potentially harmful side effects are to be avoided. The first step is to determine the state of your health and your fitness. With this information you can design an exercise prescription that will safely, effectively promote aerobic fitness.

Part 2 will help you:

- Understand the medical implications of strenuous work or exercise.
- Differentiate among the methods used to assess medical and physical fitness.
- Identify your level of aerobic fitness.
- Compare your fitness with others your age.
- Understand the factors involved in the prescription of exercise for aerobic fitness.
- Prepare a personal training prescription.
- Prepare sensible training guidelines for family and friends.

Determining Your Fitness for Exercise

Should you have a medical examination before beginning a fitness program? Here's the opinion of noted Swedish exercise physiologist, Prof. P.O. Astrand, M.D.:

> ...anyone who is in doubt about the condition of his health should consult his physician. But as a general rule, moderate activity is less harmful to the health than inactivity. You could also put it this way: A medical examination is *more urgent* for those who plan to remain inactive than for those who intend to get into good physical shape!

The American College of Sports Medicine published this advice for those over 35 years of age:

> Regardless of health status, it is advisable that any adult above 35 years of age have a medical evaluation prior to a *major increase* in his exercise habits (my emphasis).

Most authorities agree on these guidelines:

> Under 35 years: A complete medical exam within the past year.
>
> 35 and over: A recent complete examination including an exercise electrocardiogram (exercise stress test).

If pending work assignments or fitness training represents a *major increase* in your exercise habits, have a medical examination.

If you're medically fit to begin exercising, then determine your aerobic fitness. This is simply done with the step test. The 5-minute test tells your current level of aerobic fitness. If you score above 45 ml/kg/min, consider yourself in the high fitness category; 35 to 45, medium fitness; under 35, low fitness. This information about your level of fitness is necessary to:

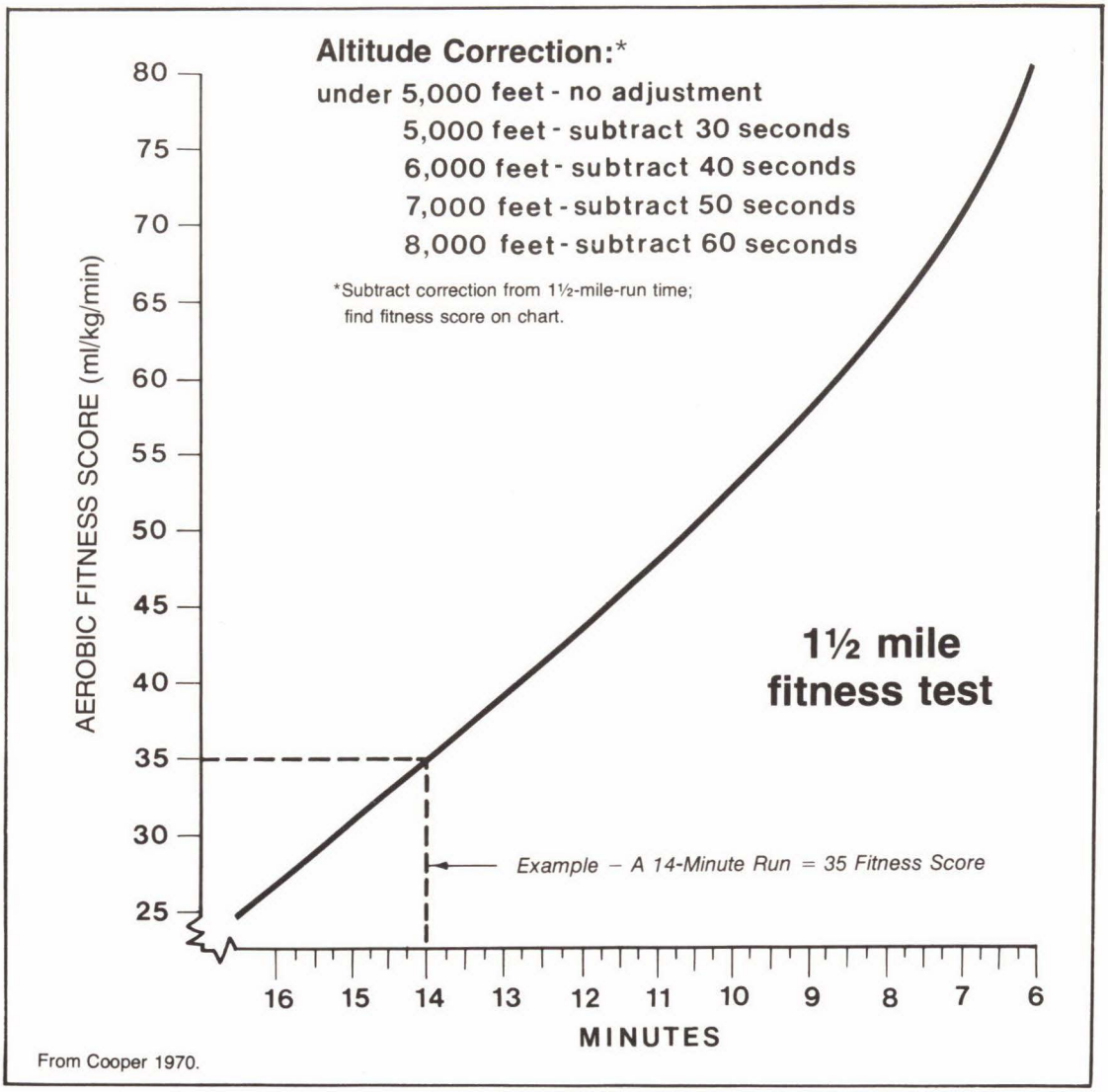
- Allow an accurate prescription of exercise.
- Provide insight regarding your work capacity.
- Evaluate progress in your training program.

If you've been completely sedentary, skip the test. Assume that you're in the low fitness category when developing your fitness prescription. If you have no way to test yourself, use the Physical Activity Index (page 14) to estimate your fitness level.

Young or extremely active individuals may prefer a more vigorous method of predicting aerobic fitness than the step test. This is the 1½ mile run, a simple test first devised by the noted work physiologist Dr. Bruno Balke. It's a fitness test based on the oxygen needed to run at various speeds and should be undertaken only if you've been training for at least 8 weeks, because it demands maximum effort.

Before the run go through a light warmup, then rest. Run the 1½ miles over a level course. Pacing and high motivation are essential for best performance. Use the chart to predict aerobic fitness and work capacity.

If you've been inactive precede the test with at least 8 weeks of training(walk-jog-run program). Those over 35 years of age should have a medical examination, including an exercise electrocardiogram before attempting the run.



From Cooper 1970.

"Before the run, go through a light warmup, then rest. Run the 1½ miles over a level course. Pacing and high motivation are essential for best performance. Use the chart to predict aerobic fitness and work capacity. If you've been inactive, precede the test with at least 8 weeks of training (walk-jog-run program). Those over 35 years of age should have a medical examination, including an exercise electrocardiogram before attempting the run."

Physical Activity Index

Calculate your activity index by multiplying your rating for each activity.

(Index = Intensity x Duration x Frequency):

	Rating	Activity
Intensity	5	Sustained heavy breathing and perspiration
	4	Intermittent heavy breathing and perspiration – as in tennis
	3	Moderately heavy – as in recreational sports and cycling
	2	Moderate – as in volleyball, softball
	1	Light – as in fishing, walking
Duration	4	Over 30 minutes
	3	20 to 30 minutes
	2	10 to 20 minutes
	1	Under 10 minutes
Frequency	5	Daily or almost daily
	4	3 to 5 times a week
	3	1 to 2 times a week
	2	Few times a month
	1	Less than once a month

Evaluation and Fitness Category

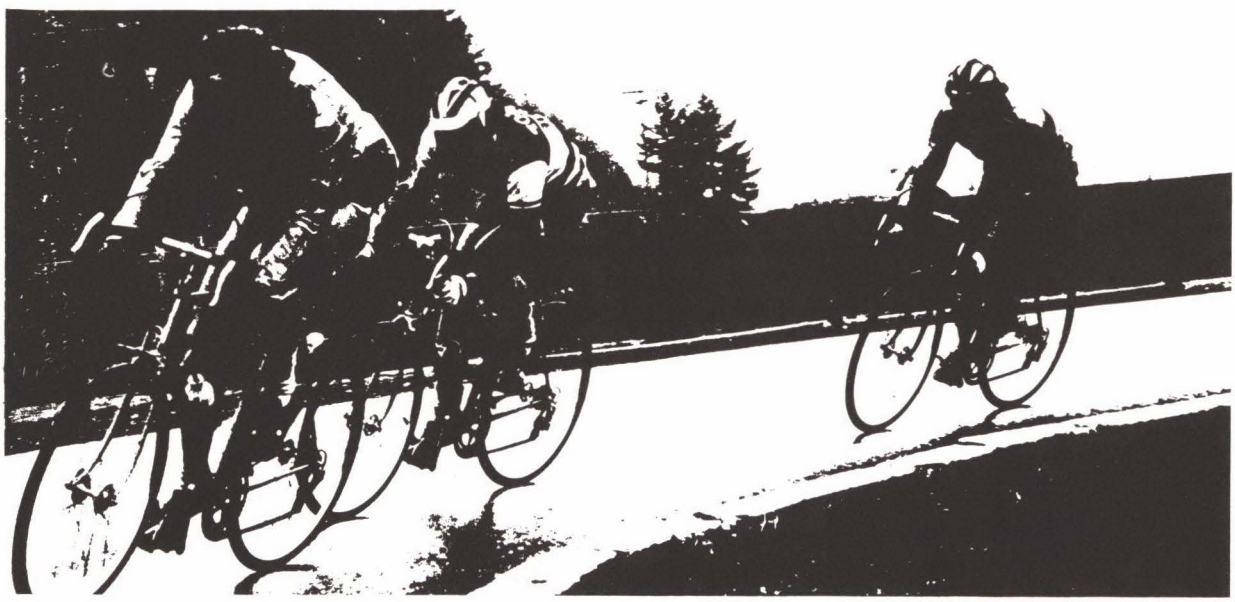
Score	Evaluation	Fitness Estimate
100	Very active lifestyle	High
60 to 80	Active and healthy	High
40 to 60	Acceptable (could be better)	Medium
20 to 40	Not good enough	Low
Under 20	Sedentary	Low

What is your current level of aerobic fitness? Compare it with others:

Fitness Comparison

Subjects	Country/Area	Men	Women
		(ml/kg/min)	
College freshmen	USA	44	37
Untrained young	USA	43	30
	Canada	49	36
	Scandinavia	59	43
Active young	USA	52	39
	Canada	55	41
	Scandinavia	59	45
Champion distance athletes	World's best	93	75
Untrained (40 to 50 years old)	USA	36	—
	Canada	39	30
	Scandinavia	45	34
Trained (40 to 50 years old)	USA	58	—

Note: U.S. athletes do well in international competition. Fitness scores among untrained groups represent differences in regular daily activity, in a lifestyle that favors the auto over the bicycle.



Your Fitness Prescription

Once you know the state of your health and your level of fitness, you are well on your way to a personal fitness prescription. The dose of exercise designed to bring about safe, steady improvements in fitness can be expressed in terms of:

Intensity = your training heart rate.

Duration = how many minutes (or calories) of exercise.

Frequency = how often you need to train.

Let's consider each factor, then summarize with ways you can prescribe your own aerobic fitness program.

Intensity

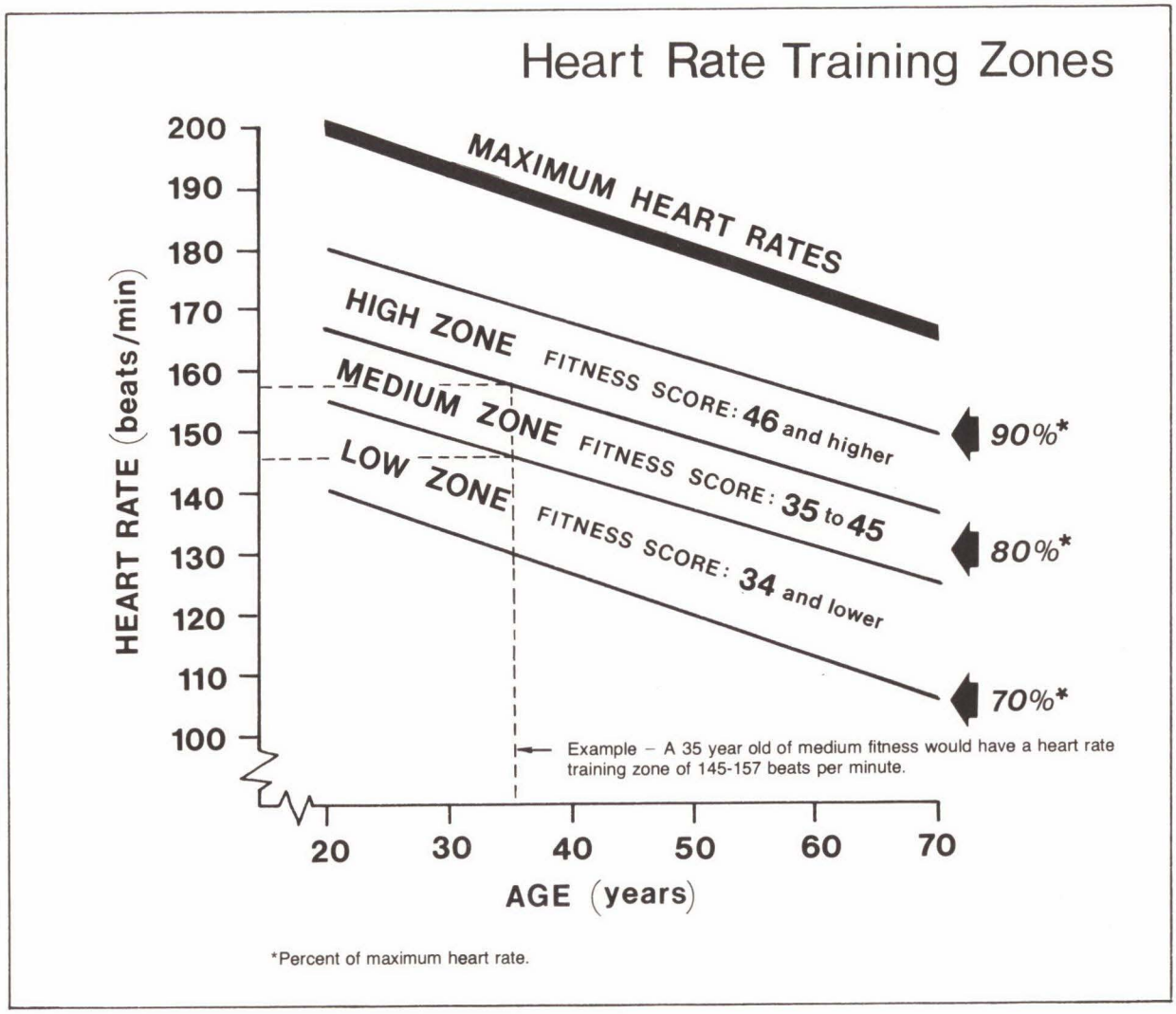
The exercise heart rate is the best indicator of exercise intensity, because it's directly related to both oxygen consumed and calories burned. As exercise becomes more intense, requiring more oxygen, heart rate increases.

Research has shown that fitness improves when you exercise at a given percentage of your maximum heart rate. The chart illustrates average maximum heart rates as well as heart rate training zones for those in low, medium, and high fitness categories. The heart rate training zone tells you how intense your exercise must be to gain a training effect. Use your age and fitness level to determine your training zone – the minimum and maximum heart rates you should attain while training.

When exercising, it's simple to determine if you're in your training zone. After several minutes of exercise, stop and take your pulse for 10 seconds at wrist or throat (with a little practice pulse taking becomes easy); multiply by 6 to get the rate per minute. For example, if you get a count of 24, your rate in beats per minute is 144. You don't need to train at near maximum levels to achieve the benefits of exercise. In fact, exercising within your training zone should feel relatively comfortable. If the zone for your age and fitness level feels uncomfortably high, don't despair. Try working at the lower edge of the zone. If that is still too high, drop to a lower zone. Your maximum heart rate is probably lower than the average for your age.

The "talk test" is another good way of determining if you're in your training zone. You should be able to carry on a conversation as you exercise. With time, you won't need to check your heart rate, because you'll know how it feels to be "in the zone."

"The chart illustrates average maximum heart rates as well as heart rate training zones for those in low, medium, and high fitness categories. The heart rate training zone tells you how intense your exercise must be to gain a training effect."



Duration

As you'll find out, exercise duration and intensity go hand in hand, because an increase in one requires a decrease in the other. Exercise duration can be prescribed in terms of time, distance, or calories. I prefer calories. The calorie is the basic measure of energy expenditure in work or exercise. It's the basic measure of energy intake (caloric intake from diet). So the calorie seems to be the most useful measure from an educational point of view.

I've included the caloric cost of several activities here; others are listed under the discussion of fitness and weight control on page 58.

	Calories per minute*	**Time taken to burn approx. 200 calories** (in minutes)
Calisthenics	5.0	40
Walking (3½ mph)	5.6	36
Cycling (10 mph)	8.5	24
Swimming (crawl)	9.0	22
Skipping Rope (120/min)	10.0	20
Jogging (5 mph)	10.0	20
Running (7.5 mph)	15.0	14

*Exact calories burned depends on efficiency and body size.

Thus, 20 minutes of jogging burns 200 calories (20 x 10 calories); 20 minutes of walking, about 112.

Aerobic Fitness Prescriptions

Fitness Category		**Intensity** *(in beats/min)*	**Duration** *(in calories)* Men	Women*	**Frequency**
High (over 45 ml/kg/min)			Over 400†	Over 300†	6 days weekly
	Age 20	164-178			
	25	162-176			
	30	160-174			
	35	157-171	— Exercise duration and frequency remain the same regardless of age —		
	40	154-168			
	45	151-164			
	50	148-161			
	55	145-158			
	60	143-155			
Medium (35-45 ml/kg/min)			200-400	150-300	6 days weekly
	Age 20	153-164			
	25	151-162			
	30	148-159			
	35	145-157			
	40	142-154	— Exercise duration and frequency remain the same regardless of age —		
	45	139-151			
	50	136-149			
	55	133-146			
	60	130-143			
Low (under 35 ml/kg/min)			100-200	75-150	Every other day
	Age 20	140-154			
	25	137-151			
	30	134-148			
	35	130-144			
	40	126-140	— Exercise duration and frequency remain the same regardless of age —		
	45	122-136			
	50	118-132			
	55	114-128			
	60	110-124			

*Caloric expenditure is less for women, because they are smaller than men and burn fewer calories in a given activity.

†For long duration workouts (over 400 calories), training intensity may be reduced to a comfortable level.

If you're in the low fitness category, your exercise should last long enough to burn *100* to *200* calories; the medium fitness category, *200* to *400* calories; and the high fitness category, more than *400* calories. It's wise to begin at the low end of the calorie scale for your fitness category. For example, if you're of medium fitness, your initial workouts should last only long enough to burn 200 calories.

If you're overweight and wish to lose excess pounds, exercise at a lower intensity (heart rate training zone) and increase the *duration.* Exercise intensity and duration can be varied to reduce boredom. In fact nothing should be rigid about your training program.

Frequency

Two or three training sessions a week are enough for those beginning a program and for those in the low fitness category. As training progresses, you can begin to exercise more; continued improvements in fitness are proportional to the frequency of training. Refer to the prescription chart for information on training frequency, as well as exercise intensity and duration. The chart also includes some aerobic activities to give you an idea how long an exercise session should last to fill your exercise prescription. The aerobic exercises listed are simply suggestions. There are many more to choose from. Selecting the right exercise is what we'll talk about next.

Sample Aerobic Activities‡

Run		**Jog**		**Bicycle**		**Swim**		**Walk**	
Distance *(miles)*	Time *(min)*	Distance *(miles)*	Time *(min)*	Distance *(miles)*	Time *(min)*	Distance *(yd)*	Time *(min)*	Distance *(miles)*	Time *(min)*
3.4+	27+	3.4+	40+	7.8+	47+	1,600+	45+	4.2+	72+
		— Distance and time remain the same regardless of age -							
1.7-3.4	14-27	1.7-3.4	20-40	3.9-7.8	24-47	800-1,600	22-45	2.1-4.2	36-72
		— Distance and time remain the same regardless of age —							
0.8-1.7	7-14	0.8-1.7	10-20	1.9-3.9	12.-24	400-800	11-22	1.0-2.1	18-36
		— Distance and time remain the same regardless of age —							

The Right Exercise

Once you've decided on your fitness prescription, your next decision is to pick the aerobic exercise or exercises you'll engage in to achieve fitness.

Your choice of exercise should depend on your fitness goal. If your goal is to improve aerobic fitness to meet job standards such as the 45 ml/kg/min for fireline work, training that relates to the job is best. This concept is called the *specificity of training.*

Years ago, before the information explosion in exercise physiology, researchers thought training for one activity provided the capability for another. We felt fitness was a general property; if you were trained and fit for swimming, you could apply that fitness in running. Today that picture has changed. The type of training should relate to the desired results. If you want to improve work capacity with handtools, you should work with them. If the goal is to improve your ability to hike long distances over mountainous terrain, hiking would be the preferred way to train.

Aerobic fitness training serves to coax a slow but continuous stream of adaptations from the working muscles. Muscles *adapt* to the regular demands imposed by training. For improvements to take place, workloads have to impose an *overload* on the muscles – the training workload must exceed regular daily demands on the muscle. The effects of training are *specific* to the demands imposed by training. Moreover, the effects are *limited* to those muscles exercised in the training.

Because overload training to improve your hiking ability or work with handtools would eventually consume many hours as fitness improves, you can use a closely related activity (jogging or fast walking uphill with a load) to increase the intensity and decrease the duration of training sessions. Various methods can be used to increase the overload during training. However, since training is specific, the training should eventually be adapted to the actual working situation.

When the job requires sustained arduous work during which the legs must support the body's weight, walking, jogging, or running should be included in the aerobic fitness program. When time for training is limited and when fitness allows, running provides a greater training stimulus per unit of time. It's moderate and rhythmic; it allows a sustained heart rate. It can be done at any hour, in any weather, with a minimum of equipment. It can be done alone or in a group. In many ways, running appears to be the best exercise.

If your goal is to improve fitness for recreational pursuits, you have a wide choice of activities that allow the necessary heart rate increase to last long enough to elicit a training effect.

A recent study compared the fitness and weight control benefits of walking, running, and bicycling. Sedentary middle-aged men trained at the same *intensity, duration,* and *frequency* for 20 weeks. All three groups improved similarly in aerobic fitness, and all showed similar weight control benefits. Remember, the benefits are the same *only* when the exercise heart rate is maintained in the training zone for the appropriate duration. Walkers will have to walk at a rapid rate or walk uphill to get the same benefits in the same amount of time as someone jogging or cycling, for example.

Walking, jogging, cycling, swimming, cross-country skiing – all are good. They're rhythmic, so

less likely to lead to injury. If you have the skill they can all be sustained long enough at a moderate rate.

The caloric cost of bicycling is influenced not only by skill but also by the gear used, the weight and quality of the bicycle, wind, hills, and so forth. Experienced cyclists often find it necessary to pedal very fast, pedal uphill, or use a higher gear to sustain a training heart rate. One approach is to work at a lower intensity for an extended period (cycle at a safer speed but burn twice as many calories). Another alternative is to work extra hard on hills and where safety permits greater speed. Before long, your fitness and skill will permit long bicycle trips.

Like cycling, the caloric cost of swimming depends on many factors besides skill: stroke, speed, and temperature.

Individuals who are unfit, unskilled swimmers, or both often find their heart rate well above their training zone, and they are unable to swim long enough to burn the necessary calories until they improve their fitness and skill.

Popular games – tennis, handball, racketball, basketball – are fine for *maintaining* fitness. But no serious fitness enthusiast considers them adequate for training. Most tennis or handball players run to get in shape for competition. Games are *not* a substitute for aerobic fitness activity. They don't allow you to maintain your heart rate in the training zone. They often include brief periods of extreme exertion. You should be fit *before* you compete in strenuous sports.

DON'T PLAY SPORTS TO GET IN SHAPE. GET IN SHAPE TO PLAY SPORTS

Applying Your Fitness Prescription

Now that we've discussed aerobic fitness and have completed a personal fitness prescription, let's put it into practice in a regular aerobic training program. Each session of your program should include warmup, aerobic fitness activity, and a cooldown period.

The warmup, which should last about 5 minutes, gradually prepares the body for the exercise to come. Begin with easy stretching exercises and then, as body temperature, circulation, and respiration adjust to the increased activity, move to more vigorous calisthenics (see part 5 for suggested warmup exercises). Pay particular attention during the warmup to:

- Stretching the lower back to reduce back problems.
- Stretching hamstring and calf muscles to prevent soreness and reduce the risk of injury.
- Increasing tempo of exercise gradually to adjust body to higher levels of intensity.

A gradual cooldown after your aerobic exercise is as important as the warmup. Complete rest immediately after exercise causes blood to pool in the veins and slows the removal of metabolic waste products. Soreness, cramps, or more serious cardiovascular complications may follow. Walking or easy jogging continues the pumping action of the muscles, promoting circulation and speeding recovery. A few minutes spent stretching also helps avoid soreness.

Never rush from a vigorous workout into a hot shower! The flow of blood to recently exercised muscles combined with the flow to the skin to dissipate heat may result in inadequate flow to the brain or heart. *Always* cool down after a workout.

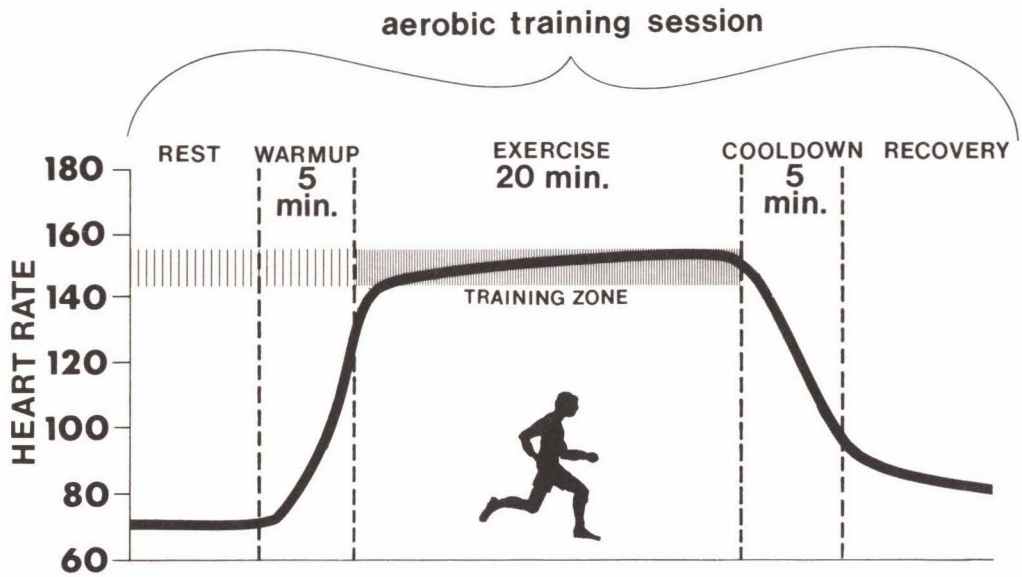
Aerobic Training Session

Warmup, aerobic exercise, cooldown – those are the elements of your training session. Let's look closer at a typical session, say for a 35-year-old man with a fitness score of 40, and see how these sessions lead to fitness.

His fitness prescription would be: **intensity**, 145 to 157 beats a minute; **duration**, 200 to 400 calories; **frequency**, every other day at the beginning, then 5 or 6 days a week with 1 day off for good behavior. He has picked jogging as his aerobic exercise. After his warmup he will jog at a 12-minute-per-mile pace for 20 minutes (1.67 miles) to burn 200 calories (20 minutes at 10 calories a minute). He can vary his session by jogging in different locales, working at the upper edge of his training zone for shorter duration, or at the lower edge for longer. After his run, he will cool down with easy jogging, walking, and stretching. It won't take too many sessions like this before he begins to experience a *training effect.*

Heart and lungs improve as the body adjusts to regular exercise, and he will soon be able to complete his session at a lower heart rate. As this happens, it's necessary to do something to insure a continued training effect. In the case of our 35-year-old jogger, he could: (1) jog the same distance at a faster pace (but calories burned remain the same); (2) cover a greater distance at the same pace (calories burned increase but intensity falls *below* training zone); (3) slowly increase both pace and distance, thereby keeping heart rate in training zone while increasing calories burned.

In practice, #3 usually occurs naturally. You increase pace without knowing it. You find yourself running faster without a greater sense of effort or fatigue. As fitness improves, it becomes easy to extend the duration of a workout. When you find this happening, you're ready to increase the intensity, duration, and frequency of your training sessions; or periodically retake the step test or run the 1½ miles for time to pinpoint your fitness level.



" Warmup, aerobic exercise, cooldown – those are the elements of your training session. "

Some training systems advocate increasing speed at the expense of duration or distance. While this approach will improve aerobic fitness, it has several drawbacks: *Risk of injury* – muscle pulls, strained ligaments, and so on increase with speed. *Discomfort increases* – many find they no longer want to go out and punish themselves; eventually they get frustrated and quit. *Bad psychology* – exercise is not something you do in a hurry to get it over with; it's a rich experience and deserves an important place in your day.

By slowly increasing *both* pace and distance you avoid these pitfalls and get several extra benefits as well. Long-duration exercise burns more calories, so you lose weight, reduce the risk of heart disease, and lower blood lipids such as cholesterol that have been associated with heart disease. It's more enjoyable, so you are more likely to continue your participation for months, years – even for life.

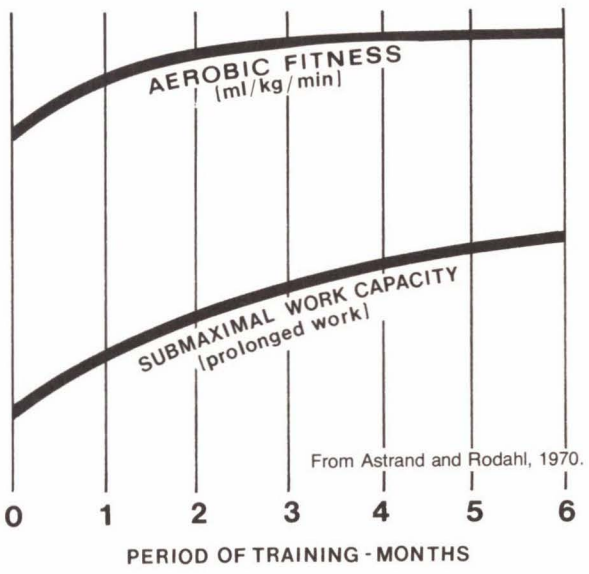
MAKE HASTE SLOWLY

Great Expectations

If you apply your exercise prescription in regular training sessions, you should expect to see a 20 to 25 percent improvement in aerobic fitness in about 3 to 6 months.[1] Overweight individuals will see even greater improvement as they lose excess fat. You'll also notice significant improvement in your performance. For example, within 6 months, you may see as much as a 2-minute drop in your 1½-mile-run performance. You'll be able to jog distances with ease – distances that once were beyond your comprehension.

But that's only part of the story. As aerobic fitness improves, and you're able to exercise longer and harder with less effort, your work capacity is increasing too. You'll be able to work at a higher percentage of your aerobic fitness level. You'll see a dramatic improvement in your performance in the field. With prolonged training, your aerobic fitness begins to plateau, but your capacity to perform submaximal work continues to improve. You'll feel better, work better. Experience shows that fit employees miss fewer days due to illness or injury.

GOOD HEALTH IS GOOD BUSINESS.



"With prolonged training, your aerobic fitness begins to plateau, but your capacity to perform submaximal work continues to improve."

[1]Improvement depends on your level of fitness and age. Sedentary people make dramatic improvements when they begin exercising. Trainability decreases as you get older. If you're under 20 you can reasonably expect a 30 percent improvement in aerobic capacity; over 70, about 10 percent.

Walk-Jog-Run Programs

Your fitness prescription gives you a great deal of freedom to tailor a personal fitness program to meet your specific work and recreation goals. You have a wide choice of exercises, and there are many options as far as the length of time you want to exercise and the intensity of that activity. Some of you, particularly those with a new-found interest in fitness, may prefer a more detailed, step-by-step approach. For this reason, I've included some walk-jog-run programs.

I'll describe programs for three levels of ability: a starter program for those in low fitness categories (under 35 fitness score), an intermediate program (35-45), and one for those in the high fitness categories (46 or better). The starter program was prepared by the President's Council on Physical Fitness and Sports and appears in the booklet *An Introduction to Physical Fitness.*

Starter Programs

Take the *walk test* to determine your exercise level.

Walk Test. The object of this test is to determine how many minutes (up to 10) you can walk at a brisk pace, on a level surface, without undue difficulty or discomfort.

If you can't walk for 5 minutes, begin with the RED walking program.

If you can walk more than 5 minutes, but less than 10, begin with the third week of the RED walking program.

If you can walk for the full *10 minutes,* but are somewhat tired and sore as a result, start with the WHITE walk-jog program. If you can breeze through the full 10 minutes, you're ready for bigger things. Wait until the next day and take the 10-minute *walk-jog test.* (Read *Running Technique,* page 52 before taking the test.)

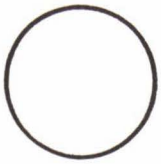
Walk-Jog Test. In this test you alternately walk 50 steps (left foot strikes ground 25 times) and jog 50 steps for a total of 10 minutes. Walk at the rate of 120 steps a minute (left foot strikes the ground at 1-second intervals). Jog at the rate of 144 steps a minute (left foot strikes ground 18 times every 15 seconds).

If you can't complete the 10-minute test, begin at the third week of the WHITE program. If you can complete the 10-minute test, but are tired and winded as a result, start with the last week of the WHITE program before moving to the BLUE program. If you can perform the 10-minute walk-jog test without difficulty, start with the BLUE program.

Red Walking Program

Week	**Activity** (every other day at first)
1	Walk at a brisk pace for 5 minutes, or for a shorter time if you become uncomfortably tired. Walk slowly or rest for 3 minutes. Again walk briskly for 5 minutes, or until you become uncomfortably tired.
2	Same as week 1, but increase pace as soon as you can walk 5 minutes without soreness or fatigue.
3	Walk at a brisk pace for 8 minutes, or for a shorter time if you become uncomfortably tired. Walk slowly or rest for 3 minutes. Again walk briskly for 8 minutes, or until you become uncomfortably tired.
4	Same as week 3, but increase pace as soon as you can walk 8 minutes without soreness or fatigue.

When you've completed week 4 of the RED program, begin at week 1 of the WHITE program.



White Walk-Jog Program

Week	**Activity** (four times a week)
1	Walk at a brisk pace for 10 minutes, or for a shorter time if you become uncomfortably tired. Walk slowly or rest for 3 minutes. Again, walk briskly for 10 minutes, or until you become uncomfortably tired.
2	Walk at a brisk pace for 15 minutes, or for a shorter time if you become uncomfortably tired. Walk slowly for 3 minutes.
3	Jog 10 seconds (25 yards). Walk 1 minute (100 yards). Do 12 times.
4	Jog 20 seconds (50 yards). Walk 1 minute (100 yards). Do 12 times.

When you've completed week 4 of the WHITE program, begin at week 1 of the BLUE program.

Blue Jogging Program

Week	**Activity** (five times a week)
1	Jog 40 seconds (100 yards). Walk 1 minute (100 yards). Do 9 times.
2	Jog 1 minute (150 yards). Walk 1 minute (100 yards). Do 8 times.
3	Jog 2 minutes (300 yards). Walk 1 minute (100 yards). Do 6 times.
4	Jog 4 minutes (600 yards). Walk 1 minute (100 yards). Do 4 times.
5	Jog 6 minutes (900 yards). Walk 1 minute (100 yards). Do 3 times.
6	Jog 8 minutes (1,200 yards). Walk 2 minutes (200 yards). Do 2 times.
7	Jog 10 minutes (1,500 yards). Walk 2 minutes (200 yards). Do 2 times.
8	Jog 12 minutes (1,760 yards). Walk 2 minutes (200 yards). Do 2 times.

Intermediate Program *(jog-run)*

If you've followed the starter program or are already reasonably active, you're ready for the intermediate program. You're able to jog 1 mile slowly without undue fatigue, rest 2 minutes, and do it again. Your sessions consume about 250 calories.

You're ready to increase both the intensity and the duration of your runs. You'll be using the heart rate training zone for those of medium fitness (35 to 45 ml/kg/min). You'll begin jogging 1 mile in 12 minutes, and when you finish this program you may be able to complete 3 or more miles at a pace approaching 8 minutes a mile. Each week's program includes three phases – the basic workout, longer runs (overdistance), and shorter runs (underdistance). If a week's program seems too easy, move ahead; if it seems too hard, move back a week or two. Remember to make a warmup and a cooldown part of every exercise session.

Week 1

Basic Workout (Monday, Thursday)

1 mile in 11 minutes; active recovery (walk). Run twice.

Underdistance (Tuesday, Friday)

¼ to ½ mile slowly.

½ mile in 5 minutes 30 seconds. Run twice (recover between repeats).

¼ mile in 2 minutes 45 seconds. Run 4 times (recover between repeats).

Jog ¼ to ½ mile slowly.

Overdistance (Wednesday, Saturday or Sunday)

2 miles slowly. (Use the talk test: Jog at a pace that allows you to converse.)

Week 2

Basic Workout (Monday, Thursday)

1 mile in 10 minutes 30 seconds; active recovery. Run twice.

Underdistance (Tuesday, Friday)

¼ to ½ mile slowly.

½ mile in 5 minutes.

¼ mile in 2 minutes 30 seconds. Run 2 times (recover between repeats).

¼ mile in 2 minutes 45 seconds. Run 2 times (recover between repeats).

220 yards in 1 minute 20 seconds. Run 4 times (recover between repeats).

¼ to ½ mile slowly.

Overdistance (Wednesday, Saturday or Sunday)

2¼ miles slowly.

Pace Guide for Gaging Speed Over Various Distances

	Pace	1 Mile	½ Mile	¼ Mile	220 Yards	100 Yards	50 Yards
		(in minutes and seconds)					
Slow Jog	10 cal/min (120 cal/mile)*	12:00	6:00	3:00	1:30	0:40	0:20
Jog	12 cal/min (120 cal/mile)*	10:00	5:00	2:30	1:15	0:34	0:17
Run	15 cal/min (120 cal/mile)*	8:00	4:00	2:00	1:00	0:27	0:13
Fast Run	20 cal/min (120 cal/mile)*	6:00	3:00	1:30	0:45	0:20	0:10

*Depends on efficiency and body size; add 10 percent for each 15 pounds over 150; subtract 10 percent for each 15 pounds under 150.

Week 3

Basic Workout (Monday, Thursday)

1 mile in 10 minutes, active recovery. Run twice.

Underdistance (Tuesday, Friday)

¼ to ½ mile slowly.

½ mile in 4 minutes 45 seconds.

¼ mile in 2 minutes 30 seconds. Run 4 times (recover between repeats).

220 yards in 1 minute 10 seconds. Run 4 times (recover between repeats).

100 yards in 30 seconds. Run 4 times (recover between repeats).

¼ to ½ mile slowly.

Overdistance (Wednesday, Saturday or Sunday)

2½ miles slowly.

Week 4

Basic Workout (Monday, Thursday)

1 mile in 9 minutes 30 seconds; active recovery. Run twice.

Underdistance (Tuesday, Friday)

¼ to ½ mile slowly.

½ mile in 4 minutes 45 seconds. Run twice (recover between repeats).

¼ mile in 2 minutes 20 seconds. Run 4 times (recover between repeats).

220 yards in 1 minute. Run 4 times (recover between repeats).

¼ to ½ mile slowly.

Overdistance (Wednesday, Saturday or Sunday)

2¾ miles slowly.

Week 5

Basic Workout (Monday, Thursday)

1 mile in 9 minutes; active recovery. Run twice.

Underdistance (Tuesday, Friday)

¼ to ½ mile slowly.

½ mile in 4 minutes 30 seconds.

¼ mile in 2 minutes 20 seconds. Run 4 times (recover between repeats).

220 yards in 60 seconds. Run 4 times (recover between repeats).

100 yards in 27 seconds. Run 4 times (recover between repeats).

¼ to ½ mile slowly.

Overdistance (Wednesday, Saturday or Sunday)

3 miles slowly.

Week 6

Basic Workout (Monday, Thursday)

1½ miles in 13 minutes 30 seconds; active recovery. Run twice.

Underdistance (Tuesday, Friday)

¼ to ½ mile slowly.

½ mile in 4 minutes 30 seconds. Run twice (recover between repeats).

¼ mile in 2 minutes 10 seconds. Run 4 times (recover between repeats).

220 yards in 60 seconds. Run 4 times (recover between repeats).

100 yards in 25 seconds. Run twice (recover between repeats).

¼ to ½ mile slowly.

Overdistance (Wednesday, Saturday or Sunday)

3 miles slowly; *increase pace* last ¼ mile.

Week 7

Basic Workout (Monday, Thursday)

1½ miles in 13 minutes; active recovery. Run twice.

Underdistance (Tuesday, Friday)

¼ to ½ mile slowly.

½ mile in 4 minutes 15 seconds. Run twice (recover between repeats).

¼ mile in 2 minutes. Run 4 times (recover between repeats).

220 yards in 55 seconds. Run 4 times (recover between repeats)

¼ to ½ mile slowly.

Overdistance (Wednesday, Saturday or Sunday)

3½ miles slowly; always increase pace near finish.

Week 8

Basic Workout (Monday, Thursday)

1 mile in 8 minutes; active recovery; run 1 mile in 8 minutes 30 seconds; active recovery; repeat (total of 3 miles).

Underdistance (Tuesday, Friday)

¼ to ½ mile slowly.

½ mile in 4 minutes. Run twice (recover between repeats).

¼ mile in 1 minute 50 seconds. Run 4 times (recover between repeats).

220 yards in 55 seconds. Run 4 times (recover between repeats).

100 yards in 23 seconds. Run 4 times (recover between repeats).

¼ to ½ mile slowly.

Overdistance (Wednesday, Saturday or Sunday)

3¾ miles slowly.

Week 9

Basic Workout (Monday, Thursday)

1 mile in 8 minutes. Run 3 times (recover between repeats).

Underdistance (Tuesday, Friday)

¼ to ½ mile slowly.

½ mile in 3 minutes 30 seconds.

¼ mile in 1 minute 45 seconds. Run 4 times (recover between repeats).

220 yards in 50 seconds. Run 4 times (recover between repeats).

100 yards in 20 seconds. Run 4 times (recover between repeats).

50 yards in 10 seconds. Run 4 times (recover between repeats).

¼ to ½ mile slowly.

Overdistance (Wednesday, Saturday or Sunday)

4 miles slowly.

Week 10

Basic Workout (Monday, Thursday)

1½ miles in 12 minutes. Run twice (recover between repeats).

Underdistance (Tuesday, Friday)

¼ to ½ mile slowly.

½ mile in 3 minutes 45 seconds. Run 3 times (recover between repeats).

¼ mile in 1 minute 50 seconds. Run 6 times (recover between repeats).

220 yards in 45 seconds. Run twice (recover between repeats).

¼ to ½ mile slowly.

Overdistance (Wednesday, Saturday or Sunday)

4 miles; increase pace last ½ mile.

Week 11

Basic Workout (Monday, Thursday)

1 mile in 7 minutes 30 seconds. Run 3 times (recover between repeats).

Underdistance (Tuesday, Friday)

¼ to ½ mile slowly.

½ mile in 3 minutes 50 seconds. Run 4 times (recover between repeats).

¼ mile in 1 minute 45 seconds. Run 4 times. Recover between repeats).

220 yards in 45 seconds. Run 2 times (recover between repeats).

¼ to ½ mile slowly.

Overdistance (Wednesday, Saturday or Sunday)

Over 4 miles slowly (more than 400 calories per workout).

Week 12

Basic Workout

1½ miles in 11 minutes 40 seconds.

You've achieved the fitness standard of 45. Proceed to the advanced aerobic fitness program.

Advanced Aerobic Training

This section is for the well-trained runner. I'll provide some suggestions for advanced training, but keep in mind there is no single way to train. If you enjoy underdistance training, by all means use it. If you find that you prefer overdistance, you'll like the suggestions offered here.

Long, slow distance running seems to be the ideal way to train. It combines the features of overdistance and underdistance with a minimum of discomfort. Simply pick up the pace as you approach the end of a long run, and you'll receive an optimal training stimulus. Moreover, since the speed work is limited to a short span near the end of the run, discomfort is brief.

Consider the following suggestions:

- Always warm up before your run.
- Use the high fitness heart rate training zone.
- Vary the location and distance of the run day by day (long-short; fast-slow; hilly-flat; hard-easy).
- Set distance goals:

  Phase 1: 20 miles a week

  Phase 2: 25 miles a week (ready for 3- to 5-mile road races)

  Phase 3: 30 miles a week

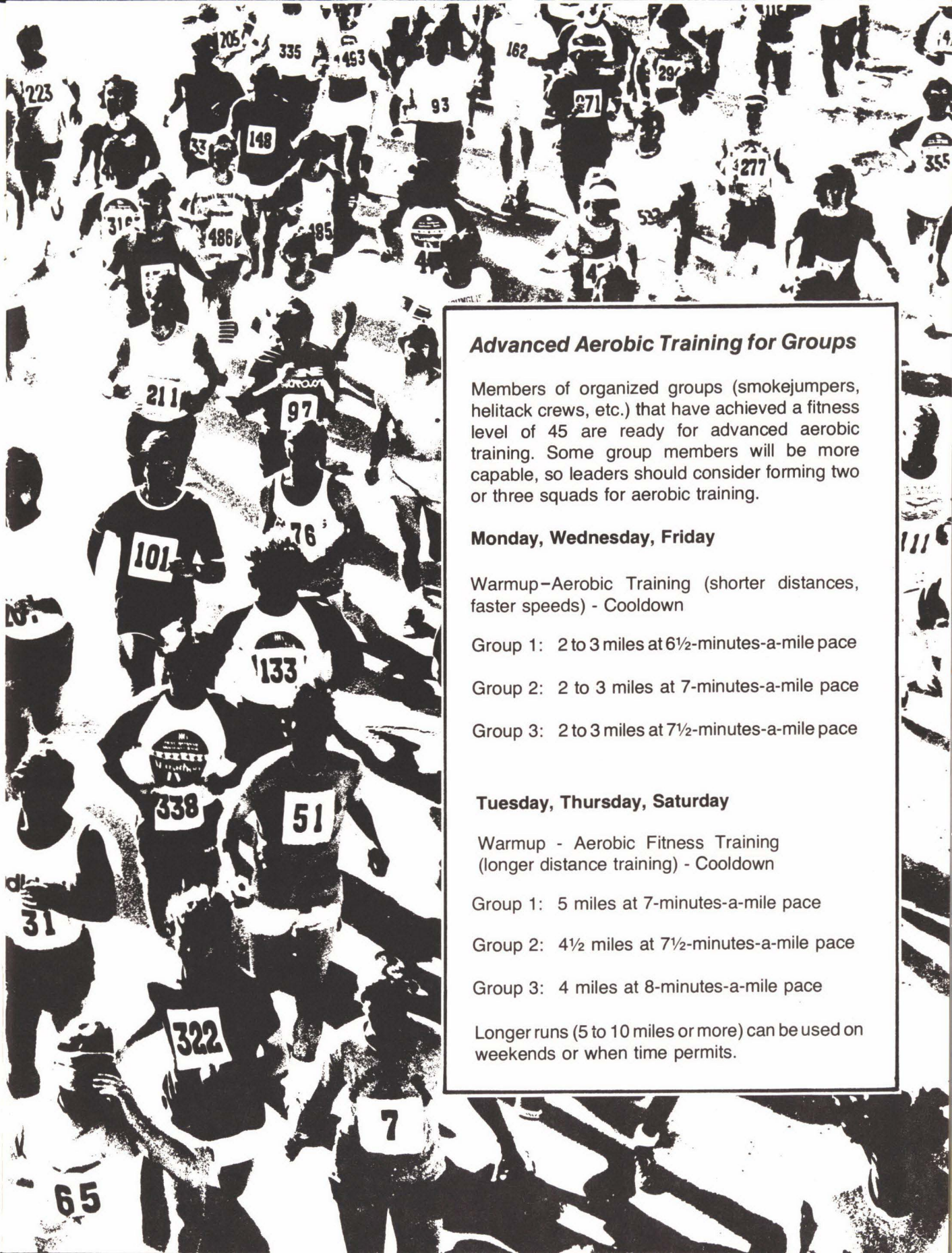
  Phase 4: 35 miles a week (ready for 5- to 7-mile road races)

  Phase 5: 40 miles a week

  Phase 6: 45 miles a week (ready for 7 -to 10-mile road races)

  Phase 7: More than 50 miles a week (consider longer races such as the marathon – 26.2 miles)

- Don't be a slave to your goals, and don't increase weekly mileage unless you enjoy it.
- Run 6 days a week if you enjoy it; otherwise, try an alternate day schedule with longer runs.
- Try one long run (not over one-third of weekly distance) on Saturday or Sunday.
- Try two shorter runs if the long ones seem difficult: 5 + 5 instead of 10.
- Keep records if you like – you'll be surprised! Record date, distance, comments. Note resting pulse, body weight. At least annually, check your performance over a measured distance to observe progress (use a local road race or the 1½-mile-run test). Check your fitness score on the step test several times a year.
- Don't train with a stopwatch. Wear a wristwatch so you'll know how long you've run.
- Increase speed as you approach the finish of a run.
- Always cool down after a run.



Advanced Aerobic Training for Groups

Members of organized groups (smokejumpers, helitack crews, etc.) that have achieved a fitness level of 45 are ready for advanced aerobic training. Some group members will be more capable, so leaders should consider forming two or three squads for aerobic training.

Monday, Wednesday, Friday

Warmup–Aerobic Training (shorter distances, faster speeds) - Cooldown

Group 1: 2 to 3 miles at 6½-minutes-a-mile pace

Group 2: 2 to 3 miles at 7-minutes-a-mile pace

Group 3: 2 to 3 miles at 7½-minutes-a-mile pace

Tuesday, Thursday, Saturday

Warmup - Aerobic Fitness Training (longer distance training) - Cooldown

Group 1: 5 miles at 7-minutes-a-mile pace

Group 2: 4½ miles at 7½-minutes-a-mile pace

Group 3: 4 miles at 8-minutes-a-mile pace

Longer runs (5 to 10 miles or more) can be used on weekends or when time permits.

Aerobic Supplements

When you're unable to engage in your regular aerobic fitness activities, consider one of these alternatives:

Skipping rope. This is such a good exercise that it can be a full-time aerobic fitness activity. The equipment is inexpensive and easy to transport. You can skip rope anywhere, even in a hotel room. The exercise allows a wide range of exercise intensities, and research studies have equated 10 minutes of *vigorous* rope skipping in cardiovascular benefit to 20 to 30 minutes of jogging.

Rope length is important. It should reach the armpits when held beneath the feet. Commercial skip ropes with ball bearings in the handles are easier and smoother to use, but a length of #10 sash cord from your local hardware store serves quite well.

Rope skipping requires a degree of coordination, and if done inappropriately can quickly raise the heart rate above your training zone. If this happens, walk or jog in place slowly, then resume skipping.

Besides the aerobic benefits, rope skipping can improve your tennis or handball, where rapid footwork is important.

"Rope length is important. It should reach the armpits when held beneath the feet.... research studies have equated 10 minutes of *vigorous* rope skipping in cardiovascular benefit to 20 to 30 minutes of jogging."

Run in place. For joggers and runners when bad weather or travel prohibits the usual run. Since it's necessary to double the time to achieve a comparable benefit, it can only be viewed as an occasional supplement.

Stationary bicycle. Several systems are available for indoor cycling. They range from the inexpensive, which involves a stand for your bicycle, to the moderate price range (under $100) for a stationary bicycle, to the expensive (approaching $1,000) for fancy cycles that include the electronics necessary to provide resistance as well as a readout of heart rate responses to workload. You can use the aerobic fitness prescriptions to achieve training benefits on the bicycle. The indoor cycle must include a mechanism for the control of resistance during cycling. Without resistance you won't be able to achieve your heart rate training zone.

Treadmill. Several relatively inexpensive (under $300) treadmills are sold. These nonmotorized devices must have an adjustable grade if they are to serve for aerobic training. Expensive motorized devices are excellent indoor training machines, but price prohibits their general use. The stationary bicycle and the treadmill often are used in post-coronary home rehabilitation programs.

Bench stepping. A sturdy bench or box can become an exercise device. By increasing the rate or duration of effort specific training effects can be realized. By wearing a loaded pack, you can emphasize the muscular fitness benefits of the exercise.

Stair running. Coaches often have their athletes run stadium steps in a combination aerobic-anaerobic-muscular fitness training program. When duration is emphasized, aerobic training predominates. When speed is emphasized, strength and anaerobic capabilities are developed. The steps in a gym, office, or apartment building provide the opportunity for extended effort.

Maintaining Aerobic Fitness

Once you've achieved the level of aerobic fitness that suits your personal needs as well as the work capacity needed for your job, you can switch to a maintenance program. Research indicates that you can maintain a given level of fitness with 2 or 3 days of activity a week. The activity must be at the same intensity and duration you employed to achieve fitness. Exercise of lesser intensity but longer duration achieves the same effect.

If a 40-year-old swims for several months to attain a fitness score of 50, he or she can maintain that level with two or three workouts a week, or one swim a week and 2 hours of tennis, 4 or 5 days a week. A periodic recheck with the step test will tell you if you are, in fact, maintaining the fitness you worked so hard to achieve.

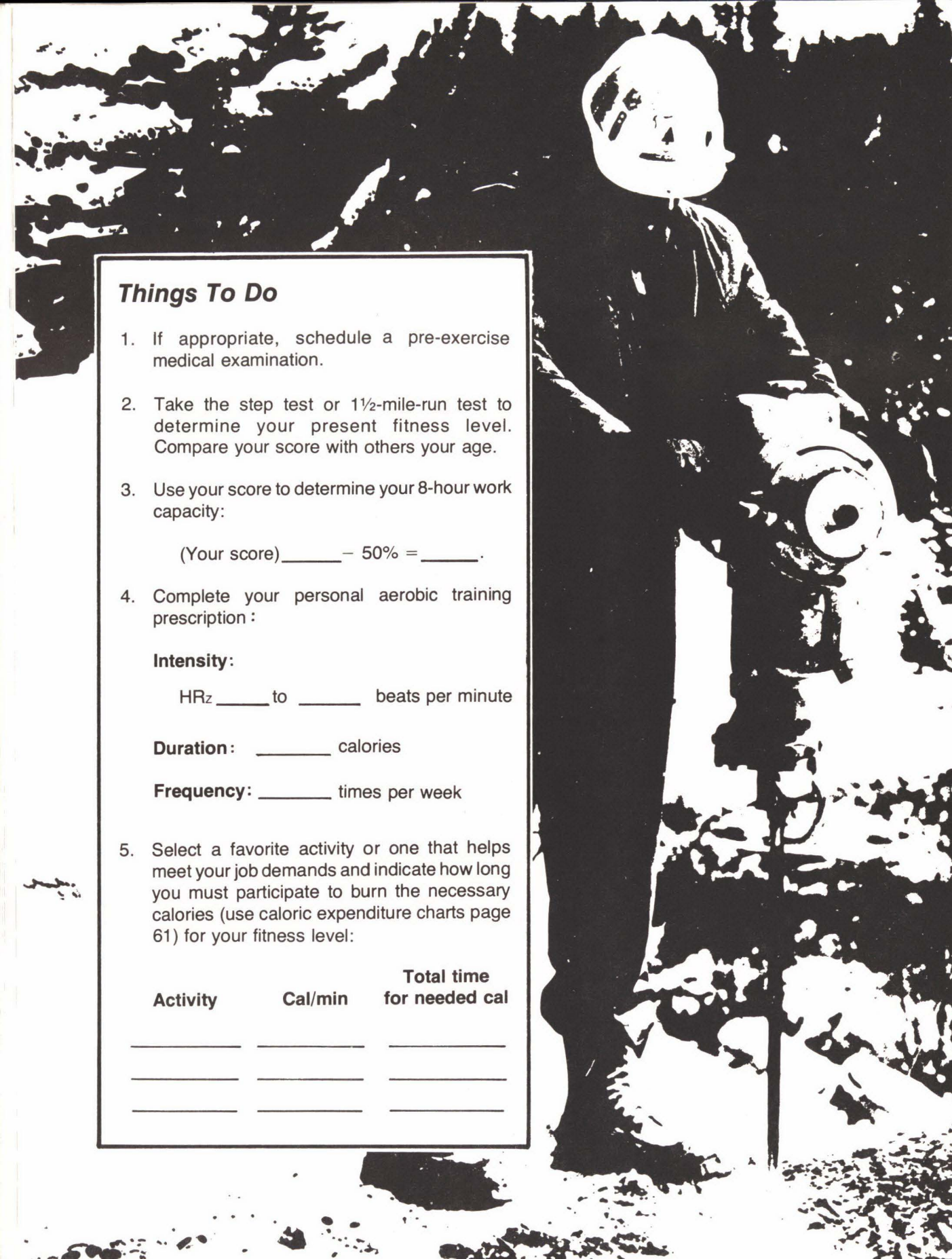
You're encouraged to seek activities you enjoy and to integrate them into your lifestyle. Before long you will find that exercise and training are no longer viewed as an obligation. When exercise becomes an enjoyable – even essential – part of your day, you'll have achieved the health, fitness, and work capacity needed to accomplish your job, and still have sufficient energy to enjoy leisure-time pursuits.

Year-round Activity

Year-round activity is the ideal way to achieve and maintain fitness. It minimizes the pain and soreness associated with the return to activity. It keeps fitness at an optimal level and minimizes the problem of weight control. Take a moment to outline your current physical activity habits on a sheet of paper. Fill in the sports or activities you enjoy each season. When you find a blank spot consider a new activity, an exercise supplement,[2] or an exercise to help you prepare for an upcoming season. This brief mental exercise will show how one activity might logically blend into the next, removing the need for extensive physical training. For example, if you cross-country ski in winter and run in the spring, you won't have to worry about your fitness for summer work projects.

	Winter	*Spring*	*Summer*	*Fall*
Major activities				
Minor activities				
Supplements				

[2]Just as vitamins supplement nutrition, specific exercises can supplement your fitness and work capacity. Example: Jog in place or skip rope as an aerobic fitness supplement during the downhill ski season.



Things To Do

1. If appropriate, schedule a pre-exercise medical examination.

2. Take the step test or 1½-mile-run test to determine your present fitness level. Compare your score with others your age.

3. Use your score to determine your 8-hour work capacity:

   (Your score)_____ – 50% = _____.

4. Complete your personal aerobic training prescription:

   Intensity:

   HR_Z _____ to _____ beats per minute

   Duration: _____ calories

   Frequency: _____ times per week

5. Select a favorite activity or one that helps meet your job demands and indicate how long you must participate to burn the necessary calories (use caloric expenditure charts page 61) for your fitness level:

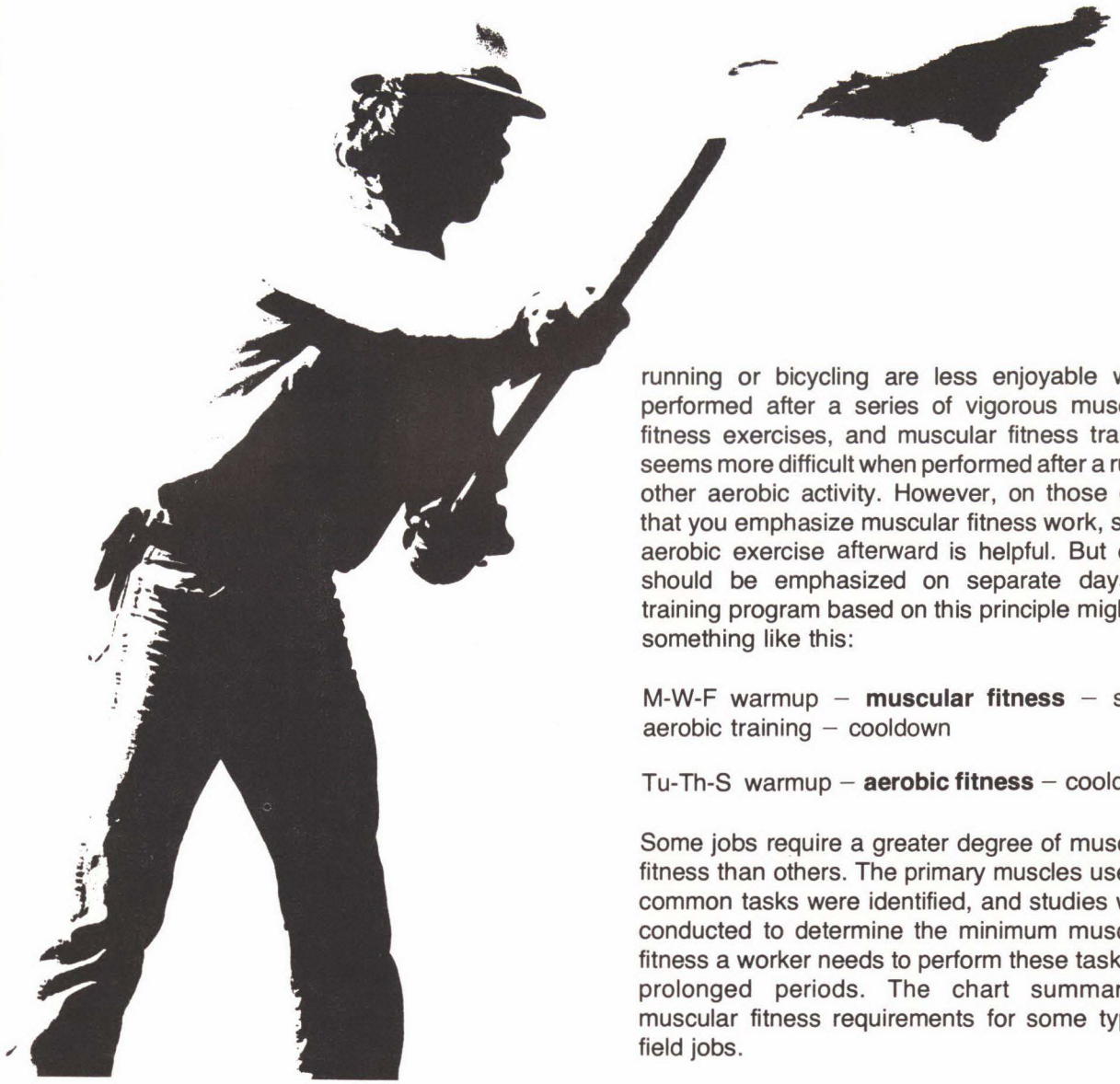
Activity	Cal/min	Total time for needed cal
_____	_____	_____
_____	_____	_____
_____	_____	_____

muscular fitness and work capacity 3

I have related aerobic fitness to work capacity and provided you with prescriptions for achieving and maintaining aerobic fitness. Like aerobic fitness, muscular fitness is an integral part of total fitness for work capacity. It depends on muscular strength, endurance, and flexibility.

Part 3 should help you:

- Assess your muscular fitness.
- Appreciate the relationship of muscular fitness to work capacity.
- Identify the components of muscular fitness.
- Prescribe exercises to develop and maintain muscular fitness.



Let's discuss the importance of muscular fitness, what level is adequate to accomplish various jobs, and prescriptions to achieve muscular fitness through weight lifting, calisthenics, or isokinetics.

If you're going to work to improve muscular *and* aerobic fitness, prescriptions for both are easily combined in an exercise program. But it's wise to emphasize one kind of activity one day and the other kind the next. Aerobic activities such as running or bicycling are less enjoyable when performed after a series of vigorous muscular fitness exercises, and muscular fitness training seems more difficult when performed after a run or other aerobic activity. However, on those days that you emphasize muscular fitness work, some aerobic exercise afterward is helpful. But each should be emphasized on separate days. A training program based on this principle might go something like this:

M-W-F warmup – **muscular fitness** – some aerobic training – cooldown

Tu-Th-S warmup – **aerobic fitness** – cooldown

Some jobs require a greater degree of muscular fitness than others. The primary muscles used in common tasks were identified, and studies were conducted to determine the minimum muscular fitness a worker needs to perform these tasks for prolonged periods. The chart summarizes muscular fitness requirements for some typical field jobs.

If you can do each exercise in the time allowed, you should be able to perform the related field tasks. Later on I'll outline muscular fitness prescriptions to achieve the strength and endurance arduous fieldwork demands.

Now let's look at the main components of muscular fitness – strength, endurance, and flexibility – to see how they relate to work capacity. Other factors of muscular fitness, such as balance, agility, and skill also will be considered.

Muscular Fitness and Work Capacity

Task	Muscle groups involved	Specific requirements	Self-testing activity	Minimum muscular fitness	
				Your wt	Repetitions
Swinging A Handtool as in chopping with pulaski, ax, McLeod	Arm & shoulder	Extensor muscle endurance	Pushup	20 in 60 sec	
	Trunk	Lower back strength and endurance	Back lift	10 repetitions	
Lifting Light Loads such as chain saw, digging and throwing dirt with shovel, lifting hose	Arm & shoulder	Flexor muscle strength	Chinup	under 110 110-135 135-175 over 175	6 5 4 3
	Trunk	Back strength	Back lift	10 repetitions	
		Abdominal muscle endurance	Situp	15 in 30 sec	
Packing Heavy Loads (50 lb)	Legs	Leg strength Leg endurance	Pack test Pack test	5 min with 50 lb on 13-inch bench at 22½ steps/min	
	Trunk	Back strength	Back lift	10 repetitions	
		Abdominal muscle strength	Situp	15 in 30 sec	
Hiking With Light Load	Legs	Aerobic endurance	Step test or 1½-mile run	45 ml/kg/min or 11:40 or under	

Muscular Strength

Dynamic muscular strength is clearly related to work capacity. Your dynamic strength is simply the most weight a specific group of muscles can lift a single time. Strength depends largely on cross section area of the muscle and connective tissue.

Training and experience also influence strength. A learning effect occurs, whereby the nervous system becomes better able to use available strength. Also, through practice and experience, we tend to lose the inhibitions that prevent us from using all the strength we possess.

Muscular strength is the primary factor limiting work capacity when a single maximum lift is involved or when using heavy tools or lifting heavy loads. But for repeated lifting, as in work with handtools, strength, muscular endurance, *and* aerobic fitness combine to set limits on work capacity.

I indicated earlier that individuals are unable to sustain workloads that exceed 50 percent of their aerobic fitness level for 8 hours. The graph illustrates combinations of work rate and load that remain within that 50-percent standard. Higher rates at the same load or higher loads at the same rate will cost more than 50 percent of the worker's aerobic fitness, and he or she will be unable to maintain that rate throughout the workday.

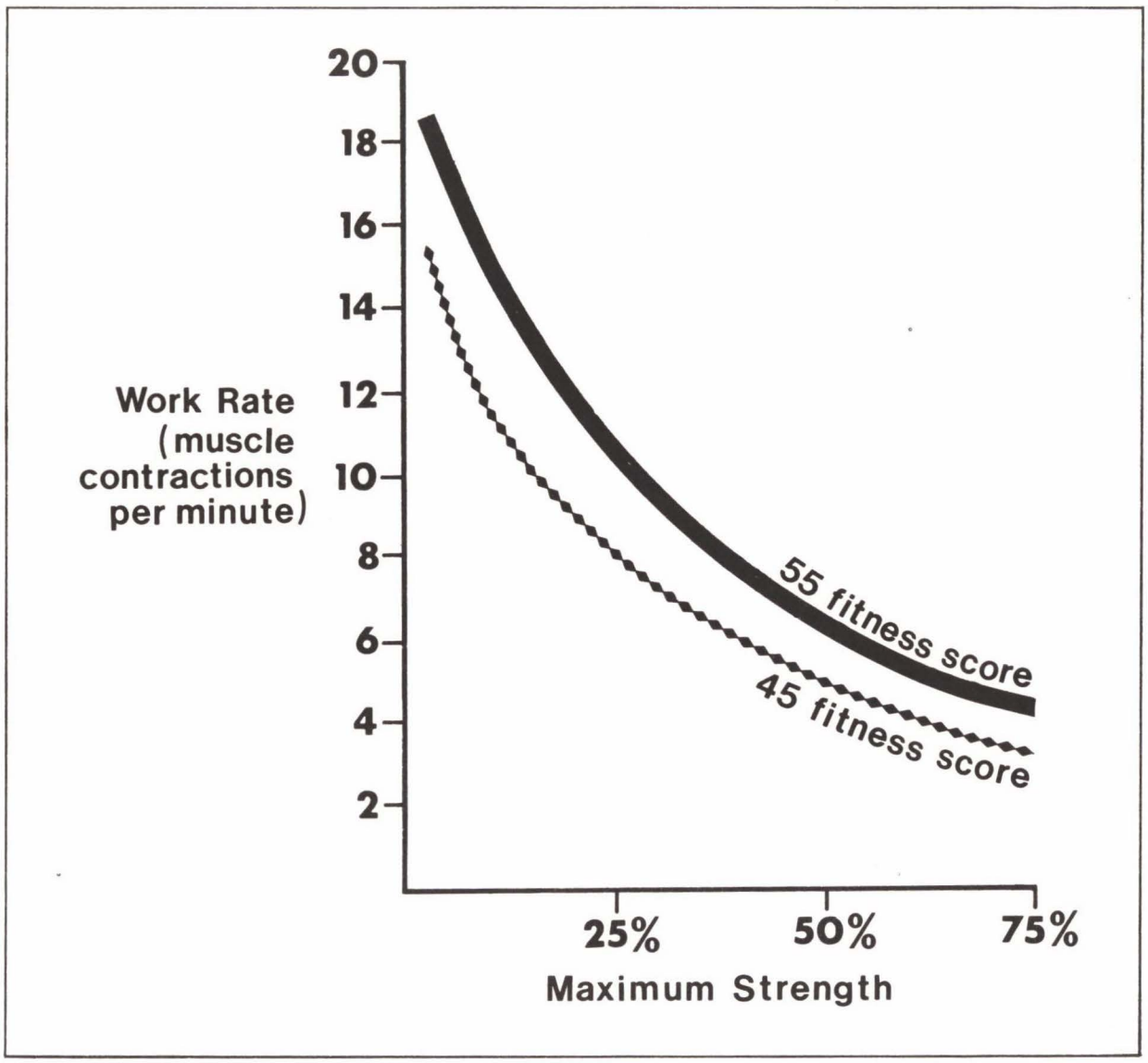
How much strength is enough? Depending on your fitness and the rate of work, **strength should be five times greater than the load encountered on the job.** For example, to wield a loaded shovel that weighs 10 pounds for long periods a worker should possess about 50 pounds of dynamic strength in the arms and shoulders (5 x 10 = 50 pounds). Once that minimum strength is achieved, further increases in work capacity can be had by increasing muscular endurance and aerobic fitness. Highly fit individuals (55 ml/kg/min) can accomplish more by working at higher work rates. The ideal combination includes above-average strength *and* high aerobic fitness – *total fitness.*

Some people, women and older men for example, may have high levels of aerobic fitness but low muscular strength. These individuals may compensate for limited strength by lifting a lighter load more often. Similarly, strength may exist independently of aerobic fitness. Strong workers may compensate somewhat by lifting heavier loads at a slower rate.

The average woman has about half the arm and shoulder strength and three-fourths the leg strength of the average man. But when strength is expressed per unit of lean body weight (fat-free weight) the woman's leg strength is comparable to the man's, although arm strength is still 30 percent below male values.

However, when women engage in strength training, as they have in several recent research studies, they gain muscular strength, and the strength isn't accompanied by an undesirable increase in muscular size. Given the opportunity, the average woman should be able to achieve the muscular fitness needed to carry out arduous work tasks.

"Highly fit individuals (55 ml/kg/min) can accomplish more by working at higher work rates."



Muscular Endurance

Muscular endurance is an essential component of work capacity. Endurance implies the ability to persist and is defined and measured by the muscle's ability to lift a load over and over. In fact, in many tasks, such as building fireline, repetitive lifting with handtools is the name of the game.

Physical conditioning increases endurance by improving the muscle fiber's aerobic energy producing capability. And tasks involving repetitive lifting depend on well-developed aerobic energy production.

Most work tasks require more endurance than strength. Many individuals mistakenly use the term strength when they really mean endurance. If an individual already has the strength to accomplish a task, physical conditioning should focus on endurance. Only those with inadequate strength need engage in strength training.

Flexibility

Flexibility is important for success in work or sport. Excessive flexibility isn't necessary, but some is helpful to assist the worker over, under, and around fallen trees and to lessen the risk of injury in most forms of vigorous activity. Flexibility is the range of motion through which the limbs are able to move. Skin, connective tissue, and conditions within joints restrict this range. Injuries occur when a limb is forced beyond its normal range. Improved flexibility can reduce the potential for injury.

The range of motion increases when joints and muscles are warmed. This suggests that a warmup concentrating on stretching the leg muscles is a good idea (see part 5 for warmup exercises). When beginning stretching exercises, for example, touching your toes, move slowly; then bob gently to further stretch muscles. Vigorous bobbing and stretching only tightens muscles. Muscles react to a sudden stretch with a reflexive contraction (stretch reflex).

Flexibility exercises are especially important when training to increase muscular strength and endurance. They help to maintain the range of motion that might otherwise be lost. Stretching exercises also help reduce muscle soreness. So stretching should be done before and after exercise, and whenever soreness occurs (usually 24 hours after vigorous effort).

Finally, flexibility becomes more important as we grow older. We have to spend more time with stretching exercises to maintain the range of motion, because tissue becomes stiff and less elastic with age. Many low back problems are the result of poor flexibility.

Other Muscular Fitness Factors

Balance

Dynamic balance is the ability to maintain equilibrium during vigorous movements such as in walking a log, jumping a stream, or carrying a heavy load. Balance depends on the ability to integrate visual input with sensory information from the semicircular canal in the inner ear and muscles (kinesthetic receptors). Although it's difficult to measure and predict how dynamic balance contributes to work capacity, ample evidence indicates that balance can be improved by physical training. Participation in sports and on-the-job experience also should improve dynamic balance.

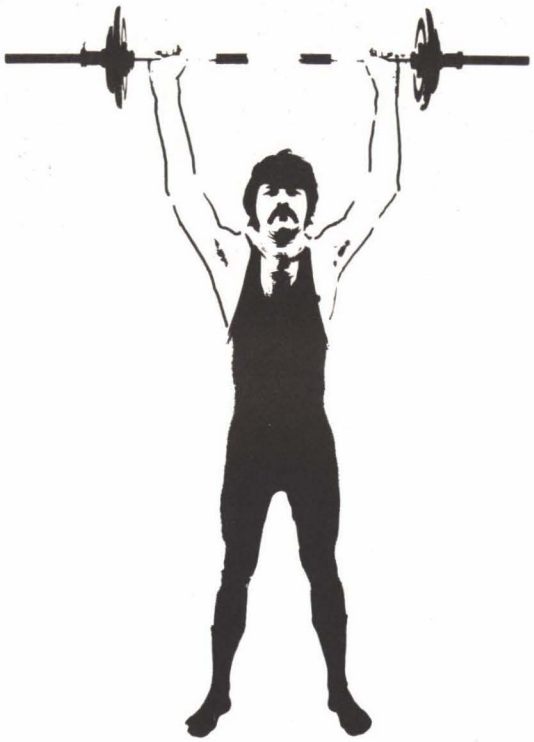
Agility

Agility is the capacity to rapidly change position and direction with precision and without loss of balance. It depends on strength and speed as well as balance. Most agility tests have been developed for the world of sport, so they relate little to work capacity. But agility is certainly important in avoiding injury, especially in unpredictable work situations such as wildland firefighting. Since agility is associated with specific skills, no one test predicts agility for all situations. Studies show that agility can be improved with practice and experience. Overweight hinders agility. Extreme muscularity isn't a prerequisite for agility. Balance and agility may deteriorate with fatigue, so we can conclude that aerobic and muscular fitness are important in maintaining both.

Skill

Every skill is specific. Ability in tennis doesn't insure success in badminton, squash, or racketball. Each skill must be learned individually, and skill isn't as easily transferred as teachers, coaches, or researchers once thought. Skill is an important factor in work capacity. Skilled workers work more efficiently; they don't waste movement or energy. A skilled worker often can outperform a stronger or more fit coworker.

Skill or technique can be learned. With proper technique the worker can make best use of leverage and large muscle groups. The skills required to work safely and effectively with tools such as the pulaski and shovel aren't complex. With good instruction most workers can reach a satisfactory level of performance in a few practice sessions.



Muscular Fitness Prescriptions

Do you need to begin a muscular fitness training program? Test yourself with the exercises shown in the chart on page 39 to determine your fitness level for arm and shoulder, trunk, and leg strength and endurance.

Prescription for Strength

Muscular strength can be increased through weight lifting, calisthenics, or in a technique called isokinetics. Suggested exercises for each of these activities are pictured in part 5.

Research has shown that strength development is optimal under these conditions:

3 sets of each exercise
6 to 8 repetitions each set
3 to 4 times a week

Weight lifting. Weight lifters use this form of training when they lift a barbell repetitively. Select a weight you can lift three or four repetitions (reps) in one set (at one time). Do three sets of exercise with that weight every *other* day of the week. Example:

1st set	rest	2d set	rest	3d set
4 reps		4 reps		3 reps (fatigue)

When you're able to lift that weight six to eight times in one set, *increase* the weight. Remember that the prescription must be followed for each muscle group. If you are attempting to build strength in several areas, for example arms, shoulders, legs, and back, you'll be doing three sets of an exercise for *each* muscle group. If you are doing four different exercises, your workout will involve 12 separate sets.

While strength doesn't increase rapidly you should expect:

- A rate of increase ranging from 1 to 3 percent a week (the untrained increase at a faster rate than the trained).
- The rate of gain to decrease as you approach your potential maximum strength.
- Improvements to take place only in the muscle groups trained — remember the concept of specificity.

Sedentary individuals who have done no lifting can expect an increase in strength of almost 50 percent after 6 months of serious weight lifting. Active persons with no lifting experience may achieve between 25 and 50 percent, while active workers who have lifted may increase only up to 25 percent, because they are approaching their potential maximum strength.

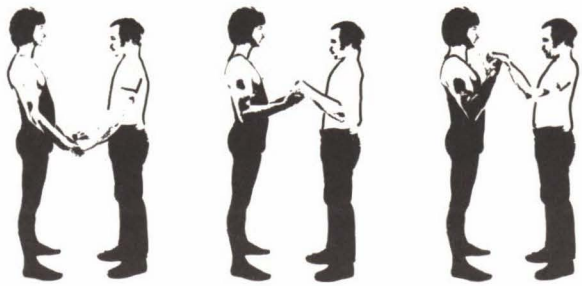
If you decide to engage in weight lifting, keep these points in mind:

- Never hold your breath during a lift. This can cause a marked increase in blood pressure and in the work of the heart. It also tends to restrict the return of blood to the heart and the circulation in the coronary arteries. So just when your heart needs more oxygen, it gets less – a dangerous situation, especially for older, unconditioned individuals. Exhale during the lift and inhale as the weight is lowered.

- Always work with a companion ready to assist when lifting heavy weights.

- Keep accurate records. Record your weights, repetitions, sets; also test for maximum strength every few weeks. Record your body weight and body dimensions – size of biceps, waist, thighs, calves.

- Alternate muscle groups during a training session. Don't do several arm exercises in a row. Also, allow recovery time between sets of the same exercise.



Calisthenics. Calisthenics may be used to increase strength if enough weight or resistance can be employed to keep the number of repetitions below 10. When more than 10 repetitions are possible, endurance and not strength will be developed.

Isokinetic exercises. As practiced in physical therapy and in exercise studios, isokinetic exercise usually involves expensive equipment. Isokinetics incorporate the best features of isometric and isotonic exercise.

Isometric – *maximum force* but at limited angles.

Isotonic – near maximum force at start, but force diminishes throughout the *range of motion.*

Isokinetic training involves a *maximum* force over *the entire range of motion.* Moreover, the exercise is accomplished without muscle soreness. You can experience the feeling by having a coworker resist your arm movement as you perform a maximum forearm curl. Your partner provides resistance throughout the range of motion. A little imagination will suggest many ways to incorporate this form of strength training. Recent research has proven the effectiveness of isokinetic exercises. Some individuals have been able to increase strength at a rate beyond 3 percent a week on a vigorous isokinetic program.

Prescription for Endurance

Once you've gained adequate strength (five times greater than the load encountered on the job), you may wish to continue weight lifting, calisthenics, or isokinetics to improve muscle endurance, which leads to improvements in work capacity. The prescription for endurance is:

3 sets
of each exercise

more than 10 repetitions each set

3 to 4 times a week

The main difference between training for strength and for endurance is in the number of repetitions. When weight lifting, muscular endurance is improved with more repetitions of a lighter weight; 10 or more repetitions are required to build endurance. When building endurance with calisthenics or isokinetics, do the maximum number possible, rest and repeat.

Endurance training should be *specific* to the way in which it will be used. Emphasize many repetitions when long term endurance is sought. When the activity involves moderately heavy work, lift with a heavier weight and do fewer repetitions, but always more than 10. Do as many as possible, rest and repeat. As with strength training, an alternate-day program is enough to produce results.

Trainability. Unlike strength training, where a 50-percent gain is difficult to attain, muscle endurance is extremely trainable. In one study a subject who could do 50 forearm curls with a 25-pound weight before training, did more than 2,000 after 8 weeks of training. That's why I emphasize the importance of endurance for work capacity. Almost everyone can swing an ax 20 or 30 times. But consider the fact that 20 swings a minute for 8 or more hours add up to more than 8,000 swings a day (depending on length of rest periods). That takes endurance.

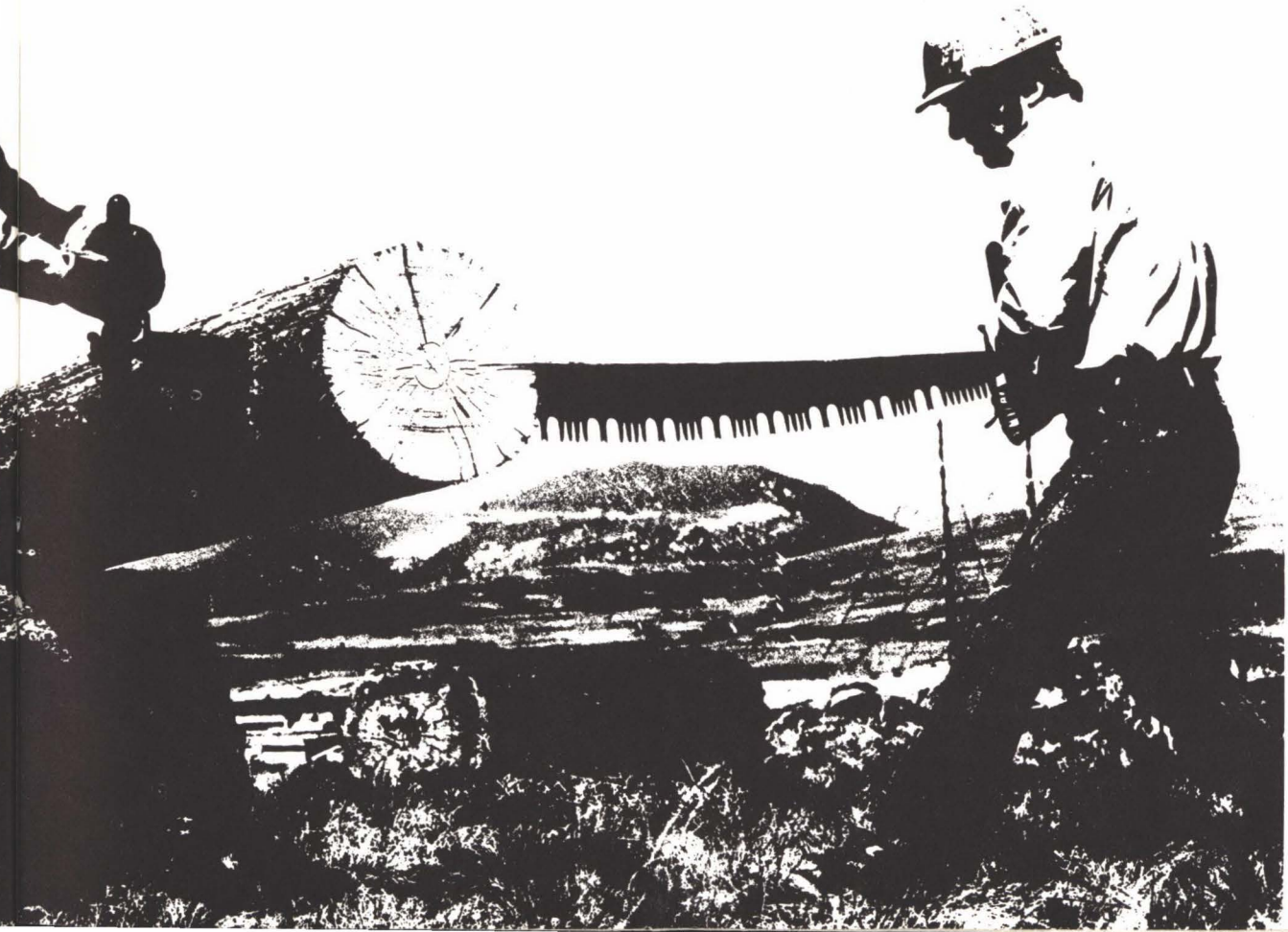
Trainability may not be as pronounced when the resistance is greater (as in a pushup). But 200, 300, and even 400 percent increases aren't uncommon following several months of training.

Research indicates the presence of two distinct fiber types in human muscles: fast twitch and slow twitch. We seem to use the slow-twitch fibers for endurance work and only call on the fast twitch for speed, heavy lifts, or after the slow-twitch fibers have been fatigued. Some world-class endurance runners have more than 80 percent slow-twitch fibers, while champion sprinters and weight lifters have a high percentage of fast-twitch fibers. But

most of us probably have about 50 percent of each type. Training will improve the strength or endurance of each type but may never change a fast-twitch fiber to a slow-twitch or vice versa.

Diet and endurance. Muscular endurance can be enhanced by a diet high in carbohydrates. Best endurance performances are recorded when a high carbohydrate diet (bread, potatoes, pasta, rice) is followed. This doesn't mean you should ignore protein or fat, only that you should emphasize carbohydrates several days before and during a period of very difficult work. It's unlikely that you'll gain weight on such a diet since hard physical work demands about 425 calories an hour. Eight hours of work at that rate, plus your basal energy needs, amount to a daily caloric expenditure of around 5,000 calories. So you can afford to stoke up on the carbohydrates several days before and during the period of arduous work. Don't continue this high caloric intake after you return to less strenuous work, unless you're eager to gain weight...quickly.

Drink lots of water when on a high carbohydrate diet. Carbohydrate is stored in a hydrated form. The excess water is useful when you begin to perspire on the job. Also, continue to eat normal amounts of protein (about 1 to 2 grams per 2.2 pounds of body weight) and fat (at least 10 percent of total calories), but reduce your intake of saturated fats for health reasons (use vegetable oil, margarine, skimmed milk). Research indicates that a diet of 80 percent calories from complex carbohydrates, 10 percent fats, and 10 percent proteins provides adequate nutrition while significantly reducing the risk of heart disease and other disorders.



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special considerations 4

I'll now consider group approaches to fitness training, how and where to exercise with an emphasis on running, some exercise problems, some problem exercises, and the contribution of fitness to weight control.

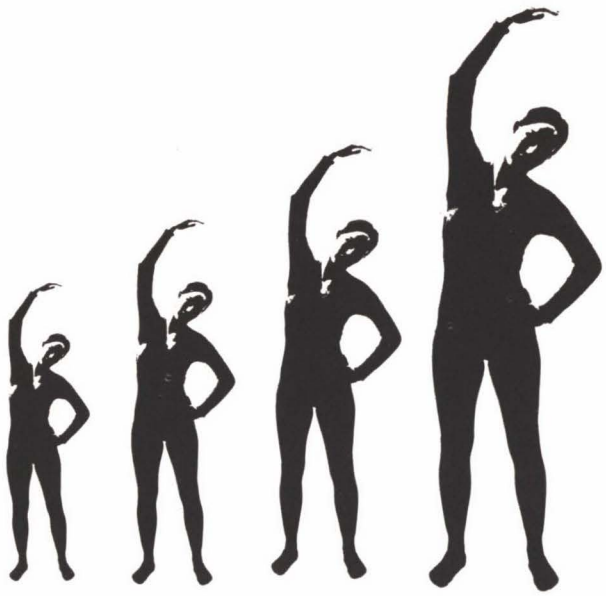
Group Fitness Training

So far our discussion of fitness has emphasized individual effort. This shouldn't discourage group training sessions. Organized groups may prefer to train as a unit. Group exercise builds team spirit and morale. Whether training together or separately, the goal is the same, to help individuals meet and maintain necessary levels of fitness and work capacity.

Part 4 should enable you to:

- Relearn the art of running for fun and fitness.
- Select appropriate footwear and clothing for your fitness training.
- Appreciate the influence of the environment on your work or exercise performance.
- Anticipate and deal with problems sometimes encountered by previously inactive adults.
- Understand the relationship of exercise, fitness, and weight control.

The success of group fitness training depends in large measure on the quality of the leadership. The effective leader provides the opportunity for group training sessions as well as individual training. The leader should attempt to assist each person to attain group as well as individual goals. This means that the leader responsible for fitness training should be well versed in the subject. He or she should be a good example; that doesn't mean being stronger or faster than every member of the group. In fact, skilled leaders seldom attempt to compete with group members. The performance of younger workers often is superior to leaders, who know better than to limit the group to their level of performance. They know when to provide others with leadership opportunities and how to use their strengths for the good of the program. Imaginative group leaders find ways to use those strengths on the job.



Here are some suggestions for program leadership:

- Line up in a consistent formation for warmup (circle, ranks, squads).
- Explain the exercise, demonstrate... "Ready, begin" (then count cadence).
- Have group count on some exercises.
- Raise voice for last few counts at end of exercise: *"One, two,* and *halt."*
- Exercise alternate muscle groups to avoid fatigue.
- Alternate order of exercise to avoid boredom.
- Do some exercises without calling cadence – for instance maximum number of pushups.
- Correct obvious errors while others exercise.
- Meet individually to discuss progress and goals.
- Break group into smaller units to help individualize program – for example, slow, average, and fast groups for aerobic training.

Some competition among groups could help increase motivation and participation. Competition could include road runs of 5 to 10 miles in which the group with the highest percentage of finishers wins; or lowest total time among groups for the 1½-mile run; or relay races of various distances. Organizing 100-mile-a- month and 200-mile-a-month clubs is another way to increase aerobic fitness.

Muscular fitness competitions could focus on which group can do the most chinups, pushups, situps, and so forth. Another idea is timed hikes or relays wearing packs. If a fitness trail is available, groups can compete for the best times in a series of exercises and running.

The possibilities for group competition are almost endless, and the rewards are improved teamwork and individual fitness efforts. But excessive competition can obscure fitness goals and can lead to unnecessary injuries.

Facilities

Parks, playing fields, and school or YMCA gyms offer possibilities as aerobic and muscular fitness training sites. The ideal situation is a place close to work. With this in mind, we suggest construction of a fitness trail near work.

The fitness trail consists of a running track and exercise stations that can be made from free or inexpensive forest products. The track can be lined with logs or "peeler cores" and filled with wood chips. Track size can vary to suit the space available. It should be at least 4 feet wide so two people can run side by side. As for length, longer tracks are more suitable (¼ to ½ mile), but shorter ones can be used (like the 1/10-mile tracks often found in gyms).

Exercise stations should include those used for muscular fitness training (chinups, step benches). Additional stations can be incorporated to suit the training needs and interests of particular groups such as smokejumpers and helitack crews.

Running

Most adults have learned to dislike physical activity – especially jogging or running. How could a natural, invigorating form of human locomotion fall into disrepute?

- Many coaches and gym teachers use running as a form of punishment: "Take a lap."
- Most adults have never learned to run properly – comfortably, sensibly. Why? The sports in our schools emphasize short intense sprints, not slow leisurely runs.
- Emphasis on "instant fitness." This is bad psychology. It teaches people to get it over with quickly. There's no place for a long slow run in this type of thinking.

We've chosen to emphasize running as an aerobic fitness activity because, for the time invested, it provides a great training stimulus. It can be done at any time, in any weather, and with little investment in equipment. And it's specific training for the many jobs that require the legs to support the body's weight during arduous work tasks. For these reasons, running appears to be the best exercise to train for forestry fieldwork.

Shoes

Nothing is so essential to your running enjoyment, so don't economize when selecting a running shoe. Go to your shoe store or sporting goods dealer for advice. Buy a training shoe, not a shoe built for competition. A firm, thick sole, good arch support, and a thick padded heel are essentials. (To test sole firmness, grip shoe on sides and squeeze; if the sole bends it's probably too soft.) A good shoe should bend easily at the toe, however. A firm heel counter is also a trait of a good shoe. Never attempt to train in an inexpensive sneaker.

A good pair of shoes can cost as much as $30. A less expensive shoe may be suitable, but be sure it offers the fit and protection the feet need for running.

Thick tube socks help prevent blisters. Some runners prefer a thin sock under a heavier outer sock.

Clothing

Jogging doesn't require fancy clothing. One of running's attractions is the fact that you don't need to spend much money. Nylon or cotton gym shorts and a T-shirt are adequate in summer. For winter running, a sweat suit or jogging suit serves until temperatures fall below 20°F. Some runners prefer cotton thermal knit long underwear under their running shorts. Several layers of lighter apparel are preferable to a single heavy garment. Add gloves and a knit cap in colder temperatures. When the wind blows, a thin nylon windbreaker helps to reduce heat loss. A cap is particularly important in cold weather, since a great deal of body heat is lost through the head.

When temperatures fall below 20°F you may choose to wear both the underwear and the sweat suit. Many continue to run despite subzero temperatures. There is no danger in doing so provided you are properly clothed, warmed up, and sensitive to signs of wind chill and frostbite.

Never wear a rubberized sweat suit in *any weather.* The water lost through perspiration doesn't contribute to long term weight loss, and your body's most effective mode of heat loss is blocked.

Running Technique

An upright posture while running conserves energy. Run with your back comfortably straight, your head up, and shoulders relaxed. Bend your arms with hands held in a comfortable position; keep arm swing to a minimum during jogging and slow running. Pumping action increases with speed. Legs swing freely from the hip with no attempt to overstride. Many successful distance runners employ a relatively short stride.

No aspect of running technique is violated more often by neophytes than the footstrike. Many newcomers say they can't or don't like to jog. Observation of their footstrike often reveals the reason: They run on the ball of the foot. While appropriate for sprints and short distances, this footstrike is inappropriate for distance runs and will probably result in soreness. The *heel-to-toe* footstrike is recommended for most runners. Upon landing on the heel, the foot rocks forward to push off on the ball of the foot. This technique is the least tiring of all, and a large percentage of successful distance runners use it. The flat-footed technique is a compromise where the runner lands on the entire foot and rocks onto the ball for push-off. Check your shoes after several weeks of running; if you're using the correct footstrike, the outer border of the heel will be wearing down.

When and Where?

Run whenever it suits your fancy. Some like to get up early and do several miles before breakfast. Others elect to run during the lunch hour, then eat a sandwich at their desk. Many prefer to wait until after work, when running can help cleanse the mind of the day's problems. A few are night owls who brave the dark in their quest for fitness; they are quick to point out that the run and shower help them to sleep like a baby. I would only caution you to avoid *vigorous* activity 1 or 2 hours after a meal, when the digestive organs require an adequate blood supply, and when any fat in the circulation hastens the risk of clotting.

Where should you run? Almost anywhere you please. Avoid hard surfaces for the first few weeks of training. Run in the park, on playing fields, golf courses, or running tracks. After a few weeks you'll be ready to try the backroads and trails in your area. By varying your routes, you'll maintain interest in your program. When the weather prohibits outdoor running, try a YMCA or school gym; or choose an exercise supplement you can do at home such as running in place or skipping rope.

Unless you are a loner and enjoy the time spent by yourself, consider running with a companion. When you find one with similar abilities, interests, and goals, you aren't likely to miss your run.

Environmental Factors

Exercise or work in hot or humid environments or at higher elevations involves special considerations.

Heat and Exercise

At moderate temperatures the body heat generated by exercise or work is easily dissipated. As temperatures increase, the temperature-regulating mechanisms increase perspiration rate to keep the body temperature from climbing above tolerable limits (about 102.5°F). (As perspiration evaporates it cools the body.) When humidity is high, it doesn't evaporate, and no heat is lost. At that point, excessive sweating only contributes to the problem. Perspiration comes from the blood and reduces blood volume. Also, salt and potassium needed by the cells are lost in perspiration.

During work in the heat, it's common to lose more than a quart of sweat an hour. During vigorous exercise in a hot, humid environment, sweat rates can approach 3 quarts an hour for short periods. A good estimate of fluid loss is the body weight difference after work in the heat. Athletes often lose 6 to 8 pounds in a single workout. Adequate replacement of water, salt, and potassium is vital to maintain exercise or work capacity and to avoid heat cramps, heat exhaustion, or heat stroke.

To replace salt loss, drink lightly salted water (¼ teaspoon of salt per quart of water), and use the saltshaker at mealtime. Avoid salt tablets. Potassium must be replaced with citrus fruits or juices. Some commercially available drinks supply fluid and electrolyte (inorganic chemicals for cellular reactions) needs. Another approach is to lightly salt lemonade or to drink tomato juice and water (or tomato juice, then water) in volumes comparable to the fluid loss.

The body adjusts or acclimates to work in the heat. Gradual exposure to exercise in a hot environment leads to changes in blood flow, reduced salt loss, and increased perspiration. After 5 to 7 days your heart rate for the same

amount of exercise may decline from 180 to 150 beats per minute. Physically fit individuals acclimate more readily to work in the heat, their well-trained circulatory systems make them better suited to its demands. Acclimated individuals should be able to replace salt loss with the saltshaker at meals.

Altitude and Exercise

As you ascend to higher elevations to work, ski, hike, or climb, be aware of limitations imposed on work capacity by reduced oxygen supply.

During the first few weeks of exposure to altitude, your ability to perform is impaired. It can be improved over a period of several weeks by training at altitude. Altitude acclimatization leads to improved lung function, increased red blood cells and hemoglobin, and increased numbers of capillaries in the working muscles. These changes reduce but never eliminate the effect of altitude on aerobic capacity.

Air Pollution and Exercise

Avoid exercise in a polluted atmosphere. Carbon monoxide takes the place of oxygen in the red blood cells, which reduces aerobic capacity. Air pollution can:

- Irritate airways (bronchitis).
- Break down air sacs in lungs (emphysema).
- Reduce oxygen transport.
- Cause cancer.

One source of pollution can do all these things – the cigarette. It's probably the worst single source of air pollution.

The U.S. Surgeon General has stated that the effects of smoking also may be harmful to the nonsmoker who is exposed to the smoke of cigarettes, cigars, and pipes. Pipe and cigar smoke is particularly unhealthy because it hasn't been inhaled into the smoker's lungs, which helps to filter out some of the harmful ingredients in the smoke.

Exercise Problems

Previously inactive adults often encounter problems when they begin exercising. You'll avoid such problems if you vow to make haste slowly. It may have taken you 10 years to get in the shape you're in and you won't be able to change it overnight. Plan now to make gradual progress. At the start, too little may be better than too much. After several weeks, when your body has begun to adjust to the demands of vigorous effort, you'll be able to increase your exercise intensity.

Another way to avoid exercise problems is to warm up before each and every exercise session. Careful attention to pre-exercise stretching and warming eliminates many of the nagging complications that plague less patient individuals. Never forget to cool down after each workout. In short, prevention is the most effective way to deal with exercise problems.

Blisters. Blisters can be prevented by wearing good, properly fitted shoes. At the first hint of discomfort, cover the area with some moleskin or a large bandage. If you do get a blister, puncture the edge with a sterilized needle to drain the accumulated fluid, treat with an antiseptic, cover with gauze, circle with foam rubber, and go back to work. It's wise to keep the items needed for blister prevention at hand.

Muscle soreness. Soreness, usually due to exercise after long inactivity, may be caused by microscopic tears in the muscle or connective tissue, or to contractions of muscle fibers. It's almost impossible to avoid soreness when you first begin exercising. Minimize it by exercising modestly, at least at first, and by doing mild stretching exercises when soreness does occur. Stretching can be used to relieve soreness and to warmup for exercise on the following day. Massage and warm muscle temperatures also seem to minimize the discomfort of soreness.

Muscle cramps. Cramps are powerful involuntary muscle contractions. Immediate relief comes when the cramped muscle is stretched and massaged. However, that does not remove the underlying cause of the contraction. Salt and potassium are both involved in the chemistry of contraction and relaxation. Cold muscles seem to cramp more readily. It's always wise to warmup before vigorous effort and to replace salt and potassium lost through sweating in hot weather.

Bone bruises. Hikers and joggers sometimes get painful bruises on the bottoms of the feet. Such bruises can be avoided by careful foot placement and by quality footwear. Cushion inner soles also help. A bad bruise can linger, delaying your exercise program many weeks. There's no instant cure once a bruise has developed, so prevention seems the best advice. Ice may help to lessen discomfort and hasten healing. Padding may allow exercise in spite of the bruise.

Ankle problems. A sprained ankle should be iced immediately. A bucket of ice water in the first few minutes may allow you to work the next day. A serious sprain should be examined by a physician. High-topped gym shoes reduce the risk of ankle sprains in games such as basketball, tennis, handball; low-cuts with thick soles invite sprains. Ankle wraps and tape allow exercise after a sprain, but again, prevention is a more prudent course.

Achilles tendon. Achilles tendon injuries have become quite common. Some high-backed running shoes have been implicated in the rash of *bursa* injuries among runners. The bursa is located beneath the tendon and serves to lubricate its movements. When rubbed long enough, it becomes inflamed. Once inflamed, it may take weeks or months to return to normal. Ice helps, but continued activity is often impossible for several weeks. Rupture of the achilles tendon

seems to be more frequent in recent years. Partial rupture occurs when some of the fibers of the tendon are torn. Complete rupture results when the tendon, which connects the calf muscles to the heel, is completely detached. Prevention is the only approach to these problems since surgery is the only cure. An inflamation of the tendon could lead to partial or complete rupture if left untreated or abused. Also, individuals with high serum uric acid levels seem prone to achilles tendon injuries. Those with high levels should have ample warmup before exercising and should avoid sudden starts, stops, and changes of direction during their exercise.

Shin splints. Pains on the lower portion of the shin bone are known as shin splints. They're caused by a lowered arch, irritated membranes, tearing of muscle from bone, a muscle spasm due to swelling of that muscle, hairline fracture of the bones of the lower leg, muscle strength imbalance, or other factors. Rest is the best cure for shin splints, although taping or a sponge heel pad seem to help in some cases. Preventive measures include exercises to strengthen shin muscles, gradual adjustment to the rigors of exercise, running on softer surfaces, occasionally reversing direction when running on a curved track, and using the heel-to-toe footstrike.

Knee problems. A knee injury suffered early in life can affect the ability to exercise. For example, a knee injured playing high school football may lead to signs of arthritis in the late twenties or early thirties. Such degenerative changes often restrict the ability to run, ski, or engage in other vigorous activities. Those of you with knee problems should consult your physician for ways to relieve the limitations they impose. Some have found that aspirin effectively suppresses the inflamation and pain often associated with exercise. Ice helps to reduce the inflamation and speed your return to activity. Knee problems also can result from improper footstrike, worn shoes, or improper foot support. Repair worn shoes, and if knee problems persist, see a podiatrist.

Low back pain. Lack of physical activity, poor posture, inadequate flexibility, and weak abdominal or back muscles cause the low back pains that beset millions of Americans. Specific exercises can strengthen one muscle group or stretch another to remove the muscular imbalance and improve the posture. By improving abdominal strength and stretching back muscles the forward tilt of the pelvis can be reduced.

Stressful exercises. Anything that is "perceived" as a threat is stressful. One of the body's responses to stressful situations is the secretion of several "stress" hormones. Associated with this response is an acceleration of the clotting time of the blood. Exercise may be stressful when it's unfamiliar, exhaustive, or highly competitive. Older individuals should begin participating in unfamiliar activities gradually, avoid exhaustion, and postpone competition until fitness and familiarity provide the proper background.

Sudden vigorous exercise. Any sudden vigorous exercise, such as shoveling snow, is a special kind of stress. Failure to warmup properly leads to cardiac abnormalities caused by an inadequate oxygen supply to the heart. A 5-minute warmup eliminates the problem.

Warning Signs[1]

As your training progresses, watch for these warning signs:

Group No. 1. If any of these occur, *even once,* stop exercising and consult your physician before resuming exercise:

Abnormal heart action – pulse irregular, fluttering, pumping or palpitations in chest or throat; sudden burst of rapid heartbeats; very slow pulse when a moment earlier it had been in training zone (this may occur during exercise or it may be a delayed reaction).

Pain or pressure in the middle of the chest or in the arm or throat, either precipitated by exercise or after exercise.

Dizziness, lightheadedness, sudden loss of coordination, confusion, cold sweat, glassy stare, pallor, blueness, or fainting. In this case, stop exercise – don't try to cool down – and lie with feet elevated or sit and put head down between legs until symptoms pass. Consult physician.

Group No. 2. Try suggested remedy briefly; if no help, consult doctor.

Persistent rapid heart action near target level and 5 to 10 minutes after exercise was stopped. To correct, keep heart rate at lower end of zone or below and increase very slowly. Consult physician if persistent.

Flareup of arthritic conditions. Rest and don't resume exercise until condition subsides. If no relief with usual remedies, consult physician.

Group No. 3. These usually can be remedied without medical consultation, though you may wish to report them to your doctor.

Nausea or vomiting after exercise. Exercise less vigorously and take a more gradual cooldown period.

Extreme breathlessness lasting more than 10 minutes after stopping exercise. Stay at lower end of training zone or below; be sure you're not too breathless to speak during exercise; if you are, stop exercising. Consult doctor.

Prolonged fatigue even 24 hours after exercising or *insomnia* not present before starting exercise program. Stay at lower end of training zone or below and increase level gradually.

Side stitch (diaphragm spasm). Lean forward while sitting, attempting to push the abdominal organs up against the diaphragm.

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[1]Adapted from *Exercise Your Way to Fitness and Health* by Lenore Zohman, M.D., 1974.

Fitness and Weight Control

Overweight and Work Capacity

Overweight is a serious problem for millions of Americans, a problem caused by a lifestyle of too little physical activity. The result has been epidemic rates of heart disease, millions of dollars wasted through lost work time, and impaired work capacity. Work capacity suffers since the overweight worker must carry his or her burden of fat around on the job, placing an extra load on the heart and lungs and restricting heat loss. With the body's mechanisms for throwing off heat restricted, performance suffers.

In some types of heavy work, muscularity may contribute to job performance. But overweight is defined as excessive body weight – be it fat *or* muscle – and research has demonstrated the risks involved in being overweight.

Most work capacity tasks don't require excessive muscular strength. And it appears reasonable and prudent to lose extra fat.

Death Rate and Overweight

10 percent overweight – 13 percent increase*

20 percent overweight -- 25 percent increase

30 percent overweight – 40 percent increase

*Increase in death rate. Source: American Medical Association.

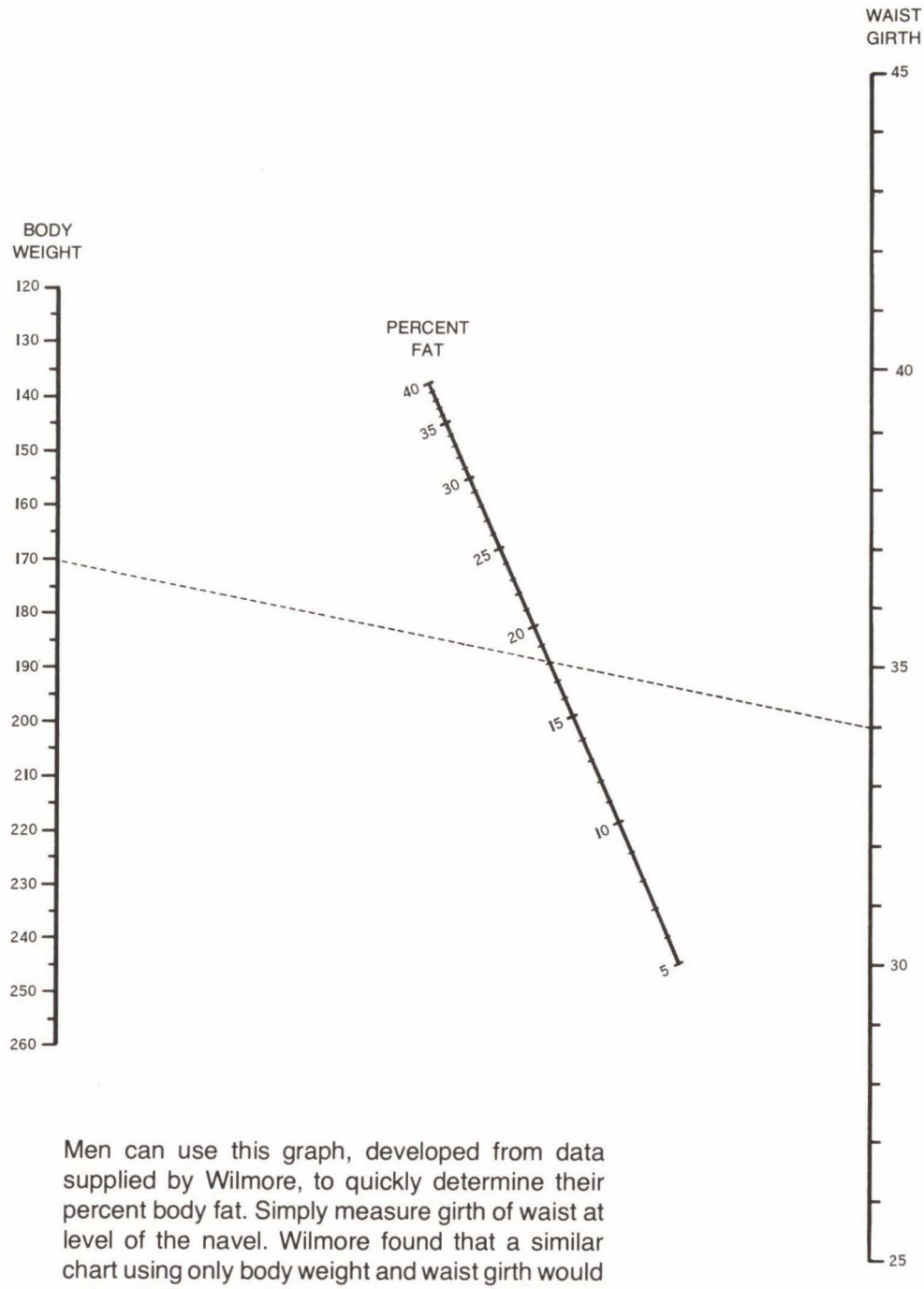
I say fat, because overweight is best understood in terms of your percentage of body fat. Use the weight table to help determine if you're overweight, but keep in mind that height-weight tables may give a false impression as to how fat you really are. Dr. Jack Wilmore, an exercise physiologist from the University of Arizona at Tucson, says it's not unusual for a person to fall within the normal range on the tables for his or her category but have 10 to 30 pounds of excess body fat. Percent body fat, then, is much more reliable than weight as a measure of weight control.

Although we can't specify precisely what your percent of fat should be, we can make some estimates, and we do know that excessive amounts pose a threat to health. Ideally, the percentages should be 10 to 15 percent for men and 15 to 22 percent for women.

Height (in inches)	*Weight in pounds*	
	Men	*Women*
60		109 ± 9*
62		115 | 9
64	133 ± 11	122 | 10
66	142 | 12	129 | 10
68	151 | 14	136 | 10
70	159 | 14	144 | 11
72	167 | 15	152 | 12
74	175 | 15	

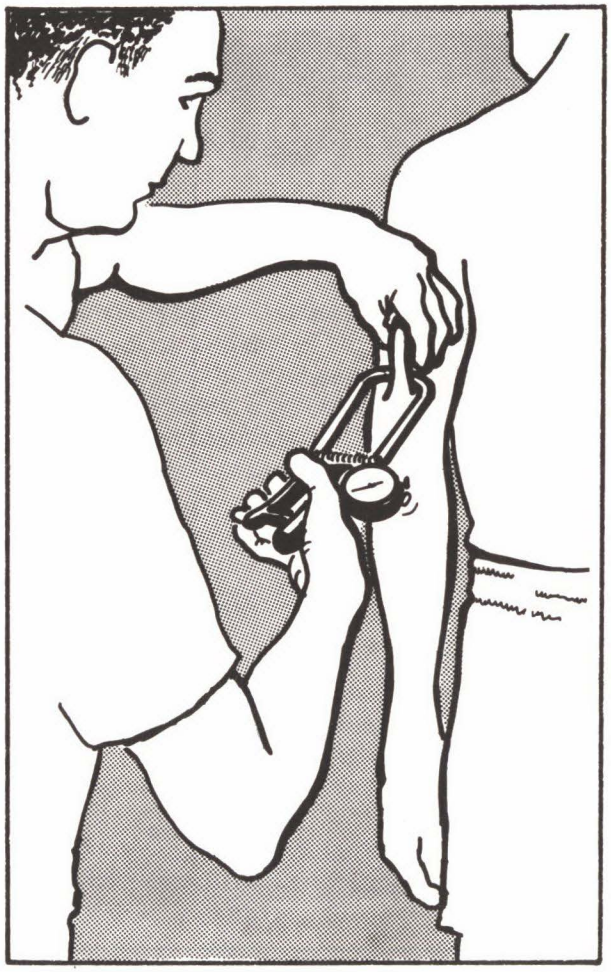
Heights and weights are without shoes and other clothing.

* Desirable weight for a small-framed woman of this height would be approximately 109 pounds minus 9 pounds, or a total of 100 pounds; for an averaged-framed woman, 109 pounds; for a large-framed woman, 118 pounds.



Men can use this graph, developed from data supplied by Wilmore, to quickly determine their percent body fat. Simply measure girth of waist at level of the navel. Wilmore found that a similar chart using only body weight and waist girth would not work for women.

Skinfold measurements also can predict fatness, because about half the body fat is right under the skin and is easily measured. Skinfold calipers are used to measure the thickness of various skinfolds on the body, and the percentage of body fat is calculated from these measurements. A simpler way to tell if you're carrying around excess fat is the pinch test. Pinch the skinfold on the back of the upper arm midway between shoulder and elbow. Don't include any muscle tissue. Remove your fingers holding the "measurement"; measure the space between your fingers with a ruler. If the width exceeds three-eighths of an inch, the accumulated fat could pose a health and work capacity problem.



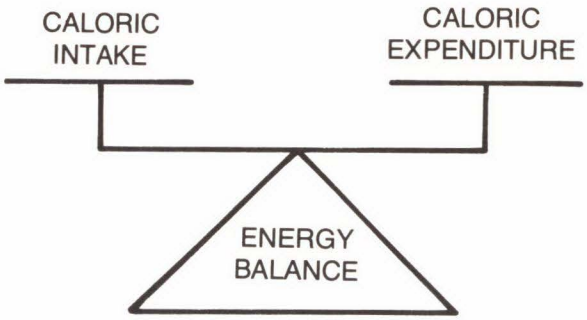
Exercise, Fitness, and Weight Control

There are two ways to lose weight: by increasing energy expenditure or by decreasing caloric intake. Weight control is essentially a problem of energy balance. A program of exercise, work, or both, and diet is the best way to achieve this balance. For a weight control exercise prescription, emphasize exercise *duration* (calories burned, miles run).

Fitness provides extra weight control benefits. When you improve your aerobic fitness you:

- Allow increased caloric expenditure without additional fatigue.
- Improve fat mobilization during exercise.
- Increase fat use during exercise.

Fitness and an active lifestyle pave the way for weight control, allow you to eat more of the things you enjoy, and provide a positive approach to one of modern man's biggest problems.



WEIGHT CONTROL IS ESSENTIALLY A PROBLEM OF ENERGY BALANCE

Calories Burned in Various Physical Activities[2]

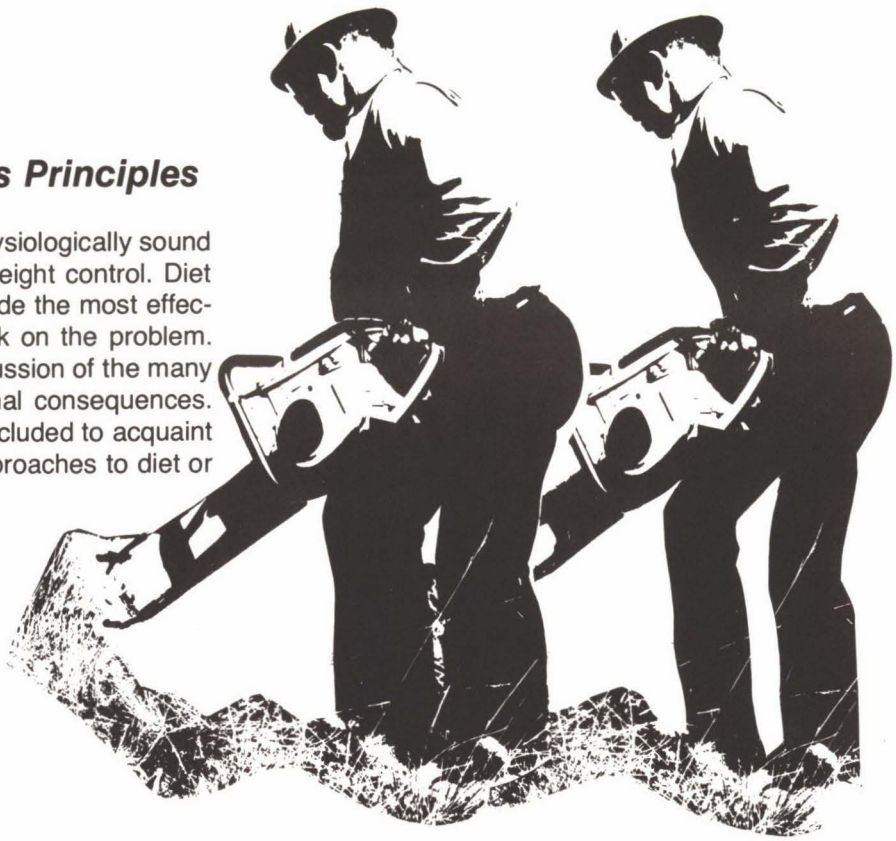
ACTIVITY	*Calories per minute*
Work Tasks	
Carpentry	3.8
Chopping wood	7.5
Cleaning windows	3.7
Clerical work	1.2-1.6
Dressing	3.4
Driving car	2.8
Driving motorcycle	3.4
Farming	
Chores	3.8
Haying, plowing with horse	6.7
Planting, hoeing, raking	4.7
Gardening	
Digging	8.6
Weeding	5.6
Hiking	
Road-field (3.5 mph)	5.6-7.0
Snow: hard-soft (3.5-2.5 mph)	10.0-20.0
Downhill: 5-10% grade (2.5 mph)	3.5-3.6
Downhill: 15-20% grade (2.5 mph)	3.7-4.3
Uphill: 5-15% grade (3.5 mph)	8.0-15.0
40-lb pack: (3.0) mph)	5.0
40-lb pack: (1.5 mph) 36% slope	16.0
House painting	3.5
Ironing clothes	4.2
Making beds	3.4
Metal working	3.5
Mixing cement	4.7
Mopping floors	4.9
Pick-and-shovel work	6.7
Plastering walls	4.1
Pulaski (depends on rate of work and other factors)	7.8
Repaving roads	5.0
Sawing	
Chain saw	6.2
Crosscut saw	7.5-10.5
Shining shoes	3.2
Shoveling (depends on weight of load, rate of work, height of lift)	5.4-10.5
Forest Service data (average)	8.0
Showering	3.4
Stacking lumber	5.8
Standing, light activity	2.6
Stone masonry	6.3
Sweeping floors	3.9
Tree felling (ax)	8.4-12.7
Truck and auto repair	4.2
Walking	
Downstairs	7.1
Indoors	3.1
Upstairs	10.0-18.0
Washing clothes	3.1
Washing and dressing	2.6
Washing and shaving	2.6

ACTIVITY	*Calories per minute*
Recreation	
Archery	5.2
Badminton (recreation-competition)	5.2-10.0
Baseball (except pitcher)	4.7
Basketball Half-full court (more for fastbreak)	6.0-9.0
Bowling (while active)	7.0
Calisthenics	5.0
Canoeing (2.5-4.0 mph)	3.0-7.0
Cycling (5-15 mph - 10-speed bicycle)	5.0-12.0
Dancing	
Modern: moderate-vigorous	4.2-5.7
Ballroom: waltz-rumba	5.7-7.0
Square	7.7
Football(while active)	13.3
Golf (foursome-twosome)	3.7-5.0
Handball and squash	10.0
Horseshoes	3.8
Judo and karate	13.0
Mountain climbing	10.0
Pool or billiards	1.8
Rowing (pleasure-vigorous)	5.0-15.0
Running	
12-min mile (5 mph)	10.0
8-min mile (7.5 mph)	15.0
6-min mile (10 mph)	20.0
5-min mile (12 mph)	25.0
Skating (recreation-vigorous)	5.0-15.0
Skiing	
Moderate to steep	8.0-12.0
Downhill racing	16.5
Cross-country (3-8 mph)	9.0-17.0
Snowshoeing (2.5 mph)	9.0
Soccer	9.0
Swimming	
Pleasure	6.0
Crawl (25-50 yd/min)	6.0-12.5
Butterfly (50 yd/min)	14.0
Backstroke (25-50 yd/min)	6.0-12.5
Breaststroke (25-50 yd/min)	6.0-12.5
Sidestroke (40 yd/min)	11.0
Skipping rope	10.0-15.0
Table tennis	4.9-7.0
Tennis (recreation-competition)	7.0-11.0
Volleyball (recreation-competition)	3.5-8.0
Water skiing	8.0
Wrestling	14.4

[2]Calories burned depends on efficiency and body size. Add 10 percent for each 15 pounds above 150; subtract 10 percent for each 15 pounds under 150.

Diet and Weight Loss Principles

Exercise provides the most physiologically sound approach to the problem of weight control. Diet and exercise combine to provide the most effective and comprehensive attack on the problem. Space doesn't permit the discussion of the many popular diets or their nutritional consequences. Some guiding principles are included to acquaint you with sound, nutritional approaches to diet or caloric restriction:



- Don't starve and stuff. Eat at least three meals a day.
- Maintain a minimal caloric intake equivalent to your basal energy expenditure.
- Eat a balanced diet, including adequate but not excessive vitamins and 1 to 2 grams of protein per kilogram of body weight per day (about ½ to 1 gram per pound per day). No more than 20 to 25 percent of your total caloric intake should be fats (reduce intake of saturated fats). The rest of your intake should be in carbohydrates (corn, rice, whole grains, potatoes, beans). Limit the sugar, soft drinks, cakes.
- Engage in regular moderate physical activity.
- Avoid an excessive caloric deficit (difference between intake and expenditure should not regularly exceed 1,000 calories).
- Practice behavior modification:

  Eat in only one room (dining or kitchen).

  Leave something you like on your plate.

  Slow your pace; pause between bites.

  Exercise before a meal.

  Engage in *light* exercise an hour or two after your main meal.

exercises 5

- ***Warmup Exercises***
- ***Muscular Fitness Exercises***
  - ***Weight Lifting***
  - ***Calisthenics***
  - ***Isokinetic Exercises***

Warmup Exercises

Here are some suggested warmup exercises. The first six should always be part of your warmup. You may wish to use some of the others or substitute your own.

1

Seated Toe Touch *(for back and hamstrings)*

With toes pointed, slowly slide hands down legs until you feel stretch; hold position and bob lightly to increase stretch. Grasp ankles and slowly pull until head approaches legs. Relax. Draw toes back and slowly attempt to touch toes. Repeat 5 times.

Variation: Try toe touch with legs apart.

2

Knee Pull *(for thigh and trunk)*

Pull leg to chest with arms and hold on count of 5. Repeat with opposite leg (8 to 10 times each leg).

Variation: Use double knee pull; do knee pull in prone position; try hurdler position.

3

Toe Pull *(for groin and thighs)*

Pull on toes while pressing legs down with elbows.

Variation: Lean forward and try to touch head to feet or floor.

4

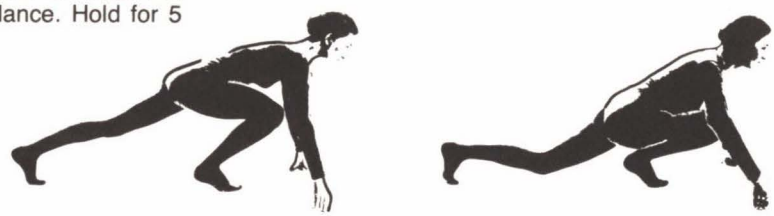
Backover *(for hamstrings and low back)*

Lie on floor. Bring legs over head and try to touch the floor with toes until you feel stretch. Hold for count of 10. Repeat stretch and relax periods for 1 minute.

5

Stride Stretch *(for groin muscles)*

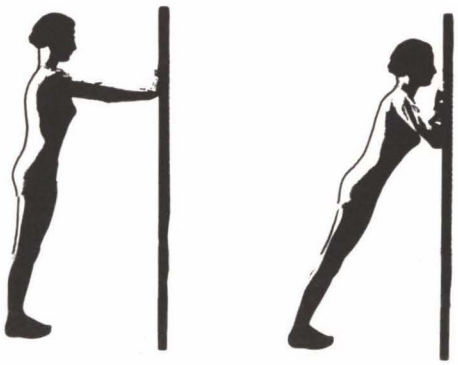
Slowly slide into stride position with front foot almost flat on floor, and rear foot on toes. Put hands on chair or floor for balance. Hold for 5 counts. Switch legs.



6

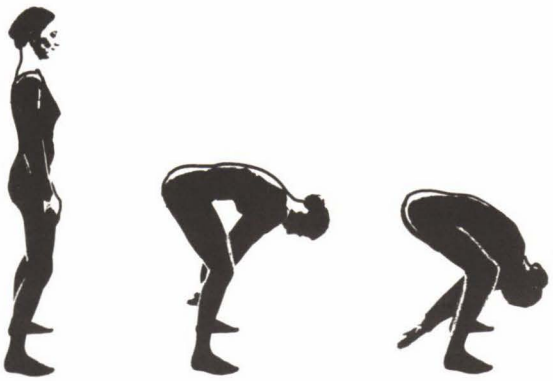
Wall Stretch *(for legs)*

Stand 3 feet from wall, feet slightly apart. Put both hands on wall. With heels on ground, lean forward slowly and feel stretch in calves. Hold position for 15 to 20 seconds. Repeat several times.



Flexed Leg-Back Stretch (for legs and back)

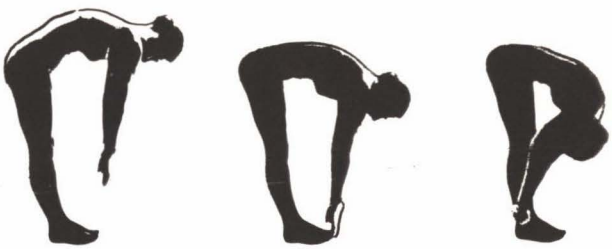
Stand erect, feet shoulder width apart. With knees slightly flexed, slowly bend over, touching the ground between the feet. Hold for 20 to 30 seconds. Repeat several times.



Standing Toe Touch *(for legs)*

With legs straight, *slowly* bend over and reach as far as possible. Hold for 5 counts – then bob lightly. Repeat several times.

Variation: Grasp back of ankles and pull until head approaches knees.



Side Bender *(for trunk)*

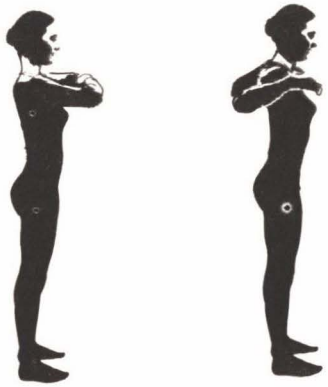
Extend one arm overhead, other on hip. Slowly bend to side; bob gently. Repeat 5 times each side.

Side Twister *(for trunk)*

With feet comfortably apart, extend arms palms down. Twist to one side as far as possible. Repeat to other side; 5 repetitions each side.

Elbow Thrust *(for shoulder and back)*

Place feet apart, arms bent, hands in front of chest, elbows out to side. Without arching back, rhythmically thrust elbows backwards, then return to starting position. Repeat 15 times.



Neck Circles *(for neck)*

With feet apart, gently roll head in full circle, first in one direction, then in the other; 3 circles each direction.

Jumping Jack (for legs and trunk)

Arms at sides. On count 1, jump and spread feet apart and simultaneously swing arms over head. On count 2, return to starting position. Use a rhythmic, moderate cadence. Repeat 15 to 25 times. Attempt variations.

Squat Thrust

On count 1, squat and place hands on floor, shoulder width apart. On count 2, thrust legs back so body is in pushup position. On count 3, return to squat and on count 4, return to standing position. Repeat 10 to 15 times. Add pushups for variation.

Run in Place

Start slowly, increase rate, height of leg lift, or both. As training progresses, run in place between subsequent conditioning exercises.

Muscular Fitness Exercises

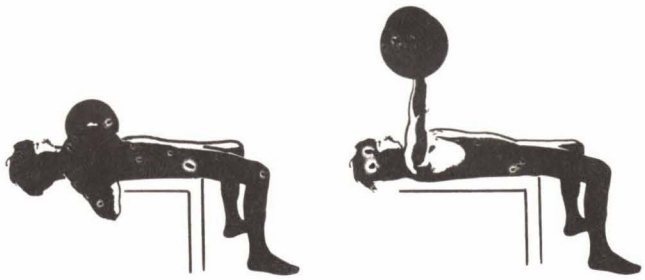
Weight Lifting

Weight lifting can be accomplished with conventional barbells or with modern weight machines. Machines are expensive, but have several advantages over barbells: safer, more versatile, save time, eliminate equipment pilferage.

These exercises are offered as suggestions for a weight training program.

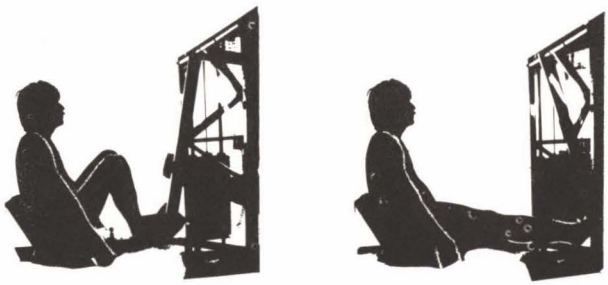
Bench Press *(for chest, arm extensor muscles)*

Lie flat on back with feet on floor astride bench. Grasp bar wider than shoulder-width apart with arms extended. Lower bar to chest. Press bar back up to starting position. Inhale while lowering weight, exhale while pressing it. Partner should assist with weight before and after exercise. Do 3 sets of up to 6 to 8 repetitions each set for strength; do more repetitions with lighter weight for endurance.



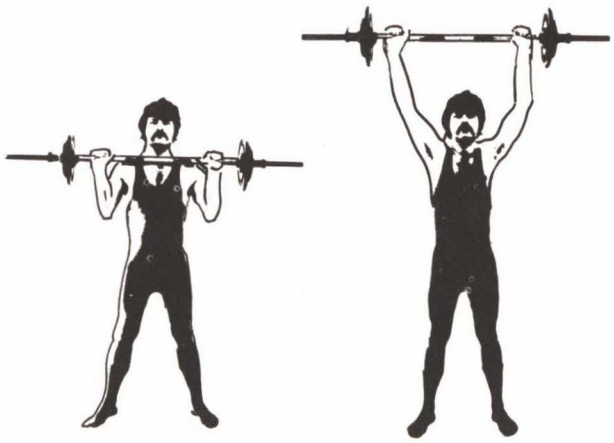
Leg Press *(for quadriceps)*

Place feet on pedals, grasp handles on seat. Press feet forward to elevate weight, return. Inhale while lowering weight and exhale while lifting it. Do 3 sets of up to 6 to 8 repetitions each set for strength; do more repetitions with lighter weight for endurance.



Military Press *(for arm and shoulder muscles)*

Stand erect with feet comfortably apart. Grasp barbell with overhand grip and raise to upper chest. Then press bar overhead, until elbows are fully extended. Lower bar to chest position; repeat. Exhale while raising weight, inhale while lowering it. Do 3 sets of up to 6 to 8 repetitions each set for strength; do more repetitions with lighter weight for endurance.



Pull Down *(for lats)*

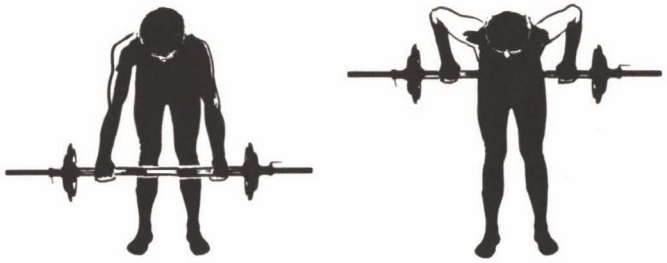
Kneel on one or both knees, grasp handles. Pull bar down to chest and return to starting position. Do 3 sets of up to 6 to 8 repetitions each set for strength; do more repetitions with lighter weight for endurance.

Curls *(for biceps)*

Stand erect, feet comfortably apart, knees slightly flexed. Hold bar in front of thighs with underhand grip shoulder-width apart, arms straight. Flex elbows fully, lifting bar toward chest. Keep elbows close to sides and avoid raising shoulders. Don't lean backward or "bounce" bar with leg motion. Return to starting position. Exhale while raising bar, inhale while lowering it. Do 3 sets of up to 6 to 8 repetitions each set for strength; do more repetitions with lighter weight for endurance.

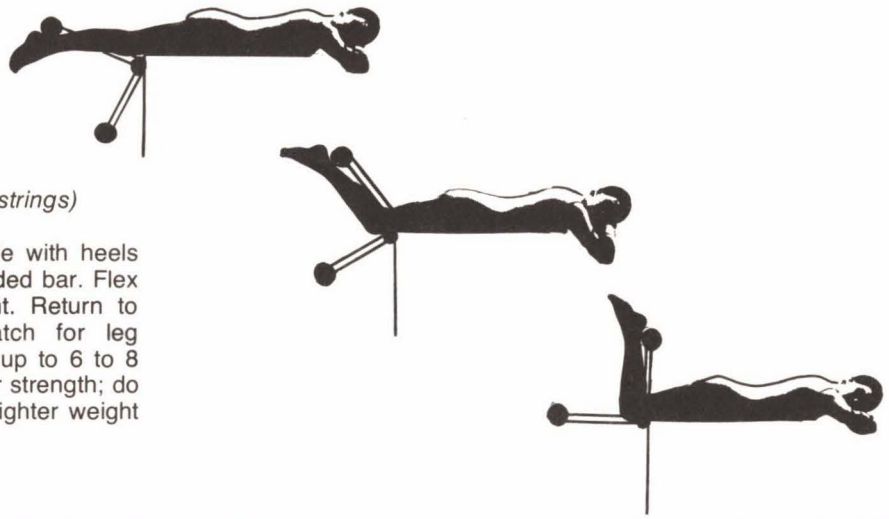
Bent Rowing *(for lats)*

Stand in bent over position, back flat and slightly above parallel with floor. Spread feet shoulder width, with knees comfortably bent. Grasp barbell with an overhand grip; hands should be slightly wider than shoulder width. Keep buttocks lower than shoulders. Pull bar from floor to chest. Lower bar to starting position (completely extend elbows). Exhale while lifting from floor, inhale while lowering. Keep upper body stationary. Do 3 sets of up to 6 to 8 repetitions each set for strength; do more repetitions with lighter weight for endurance.



Tricep Extension *(for triceps)*

Sit astride bench with back straight. Grasp bar about 2 inches apart using overhand grip. Bring bar to full arm extension above head. Lower bar behind head, keeping elbows stationary. Do 3 sets of up to 6 to 8 repetitions each set for strength; do more repetitions with lighter weight for endurance.



Leg Flexion *(for hamstrings)*

Lie face down on table with heels positioned behind padded bar. Flex legs to elevate weight. Return to starting position. Watch for leg cramps. Do 3 sets of up to 6 to 8 repetitions each set for strength; do more repetitions with lighter weight for endurance.

Leg Extension *(for quadriceps)*

Sit on table with instep under padded bar. Extend leg to elevate weight. Return to starting position. Do 3 sets of up to 6 to 8 repetitions each set for strength; do more repetitions with lighter weight for endurance.

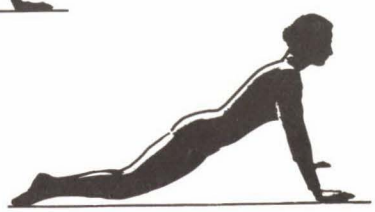
Calisthenics

Arm and Shoulder: Extension Strength and Endurance

Knee Pushup *(beginner)*

With hands outside shoulders and knees bent, push up keeping back straight. Do as many as possible.

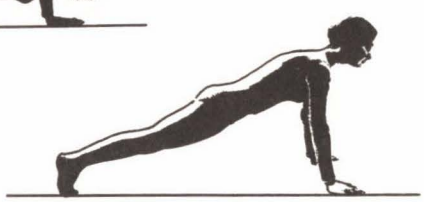
Variation: Use a low bench and do pushup with hands on bench, body straight.



Pushup *(intermediate)*

With hands outside shoulders, push up keeping back straight; return until chest almost touches floor. Do as many as possible.

Variation: Push up and clap hands; do fingertip pushups.



Chair Dips *(advanced)*

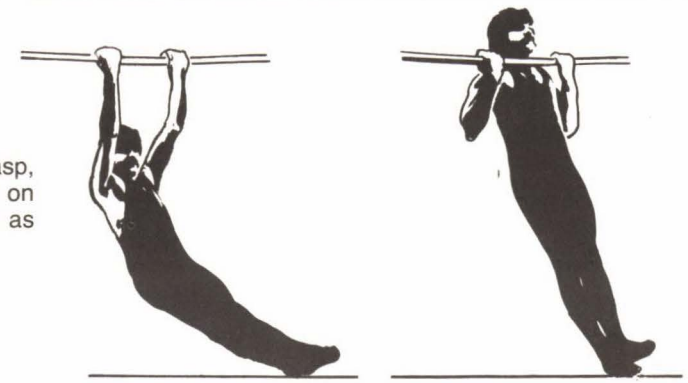
Be sure chair is stationary. Grasp sides of chair, slide feet forward while supporting weight on arms. Lower body and return. Do as many as possible.

Variation: Use parallel bars if available.

Arm and Shoulder: Flexion Strength and Endurance

Modified Chinup *(beginner)*

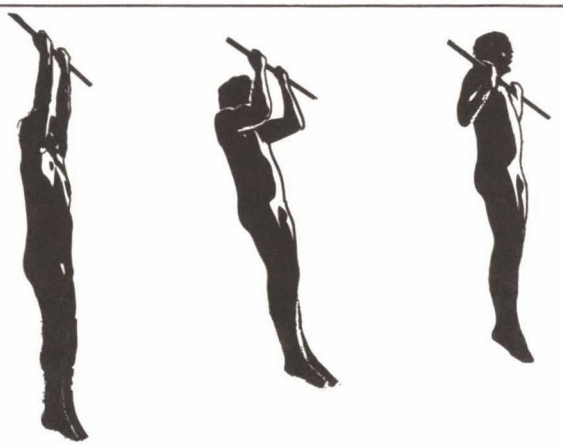
Bar about chest high. With underhand grasp, hang from bar with body straight and feet on ground. Pull up and return. Do as many as possible.



Chinup *(intermediate)*

With underhand grasp, pull up until the chin is over bar; return. Do as many as possible.

Variation: Rope climb.

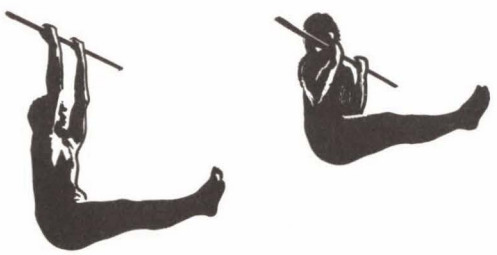


Flexed Arm Hang *(beginner)*

With underhand grasp and the assistance of a companion, raise body until chin is above bar and arms flexed. Hold position as long as possible. Let down as slowly as possible.

Pike Chinup *(advanced)*

Chin up with legs in pike position.



Abdomen: Strength and Endurance

Curlup *(beginner)*

On back with arms at sides, curl head and shoulders off floor (be sure chin stays on chest). Hold for 5 counts and relax. Do 10 to 15 times.

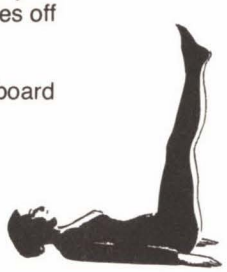
Situp – Arms Crossed *(low intermediate)*

On back with arms crossed on chest and knees bent, curl up to sitting position and return. Do 10 to 15 times.

Leg Lifts *(intermediate)*

On back with arms at sides, lift legs slowly to 90-degree angle; slowly return, hold 6 inches off ground (keep back flat).

Variation (advanced): Do leg lifts on a tilt board (head up).



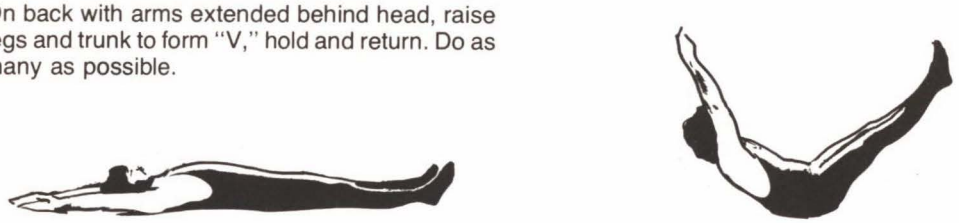
Situp *(high intermediate)*

On back with knees bent and fingers laced behind head, curl up to sitting position and touch right elbow to left knee and return. Do as many as possible, alternating right and left elbow touch.

Variation: Do repetitions very fast; do on inclined board; hold weight behind head.

"V" Sit *(advanced)*

On back with arms extended behind head, raise legs and trunk to form "V," hold and return. Do as many as possible.



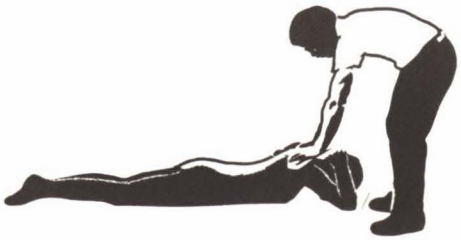
Basket Hang *(advanced)*

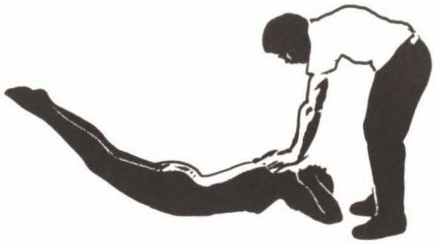
Hang from bar with underhand grasp. Raise legs into "basket" and return. Do as many as possible.

Back: Strength and Endurance

Leg Lifts

Face down on floor with partner holding trunk down, raise legs 5 to 10 times.

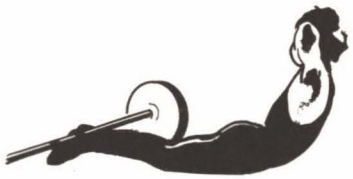




Back Lifts

With face down on floor, fingers laced behind head, and ankles held down, raise trunk 5 to 10 times.

Variation: Do from edge of sturdy table or bench for greater range of motion.



Side Leg Lifts

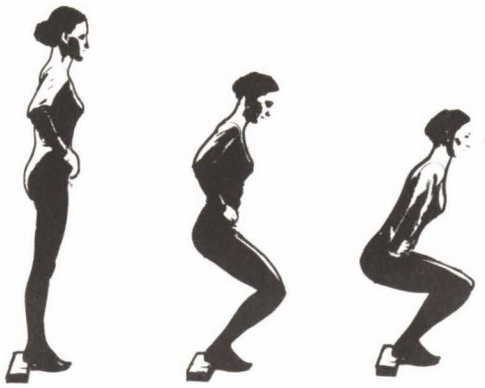
Lie on side, head supported by elbow and hand, other hand on floor in front. Lift leg as high as possible, return; 10 to 20 times each leg.

Leg: Strength and Endurance

Half Knee Bends

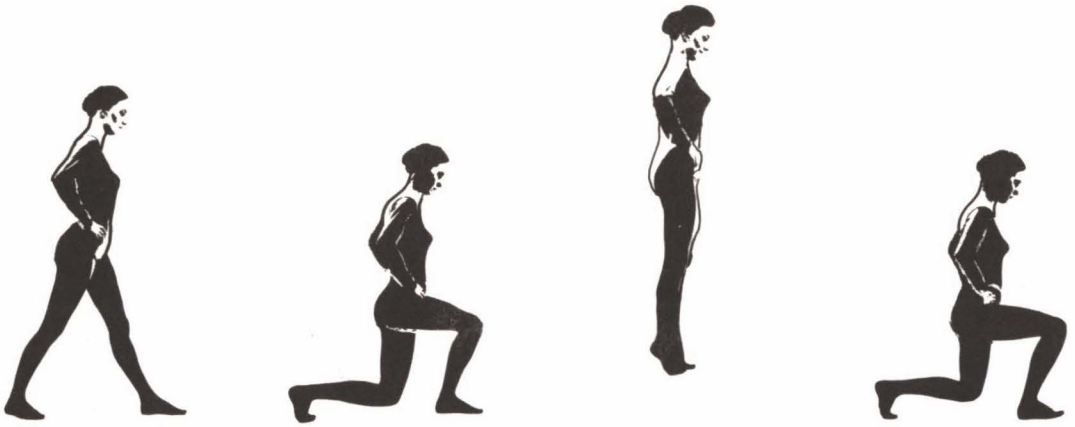
Feet apart, hands on hips, squat until thighs parallel to ground, return. Do as many as possible. Try 2-inch block under heels to aid balance.

Variation: Do with weight on back, for example a backpack.



Squat Jumps

Stand with hands on hips, one foot a step ahead of the other. Squat until legs at 90-degree angle, jump as high as possible, extending the knees. Switch position of feet on way down and jump again; 10 to 20 repetitions.



Hill Running

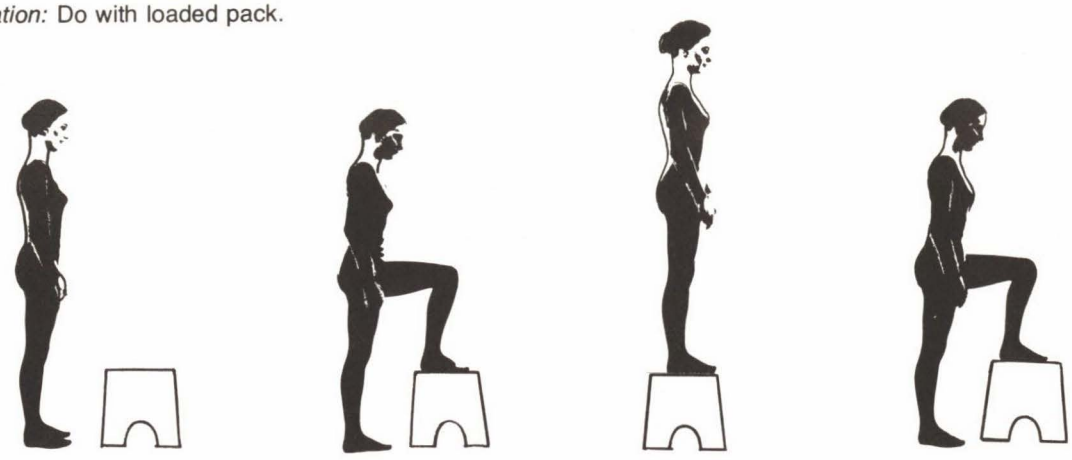
Run up and down a steep hill.

Variation: Use the stairs of a gym, stadium, or office building.

Bench Stepping

Step up and down on bench as fast as possible for 1 minute.

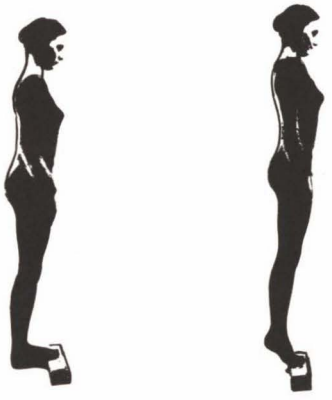
Variation: Do with loaded pack.



Heel Raises

Stand erect, hands on hips, feet close together. Raise up on toes 20 to 40 times.

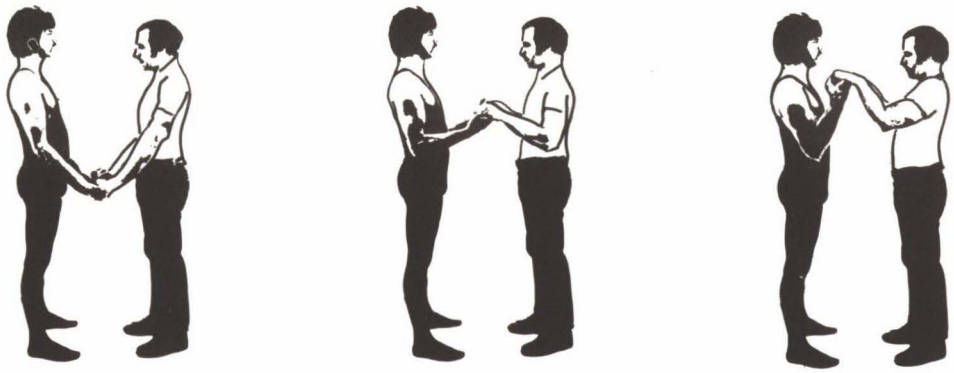
Variation: Do with toes on 2-inch platform; do with loaded pack.



Isokinetic Exercises

Arm Flexion

As #1 tries to move arms up, #2 resists movement; #2 should allow movement to progress slowly (range of motion in 3 seconds). Do 3 sets of 8 repetitions.

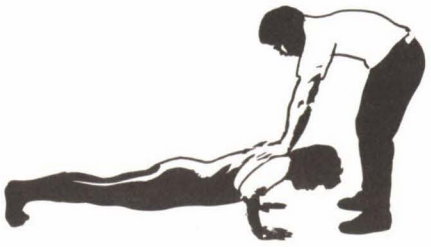


Arm Extension

As #1 tries to extend arms down, #2 resists movement; #2 should allow movement to progress slowly (range of motion in 3 seconds). Do 3 sets of 8 repetitions.

Pushup

As #1 does conventional pushup, #2 provides resistance. Do 3 sets of 8 repetitions. Switch places between sets to allow time to rest.



Leg Flexion

As #1 tries to flex leg, #2 resists movement; #2 should allow movement to progress slowly through range of motion in 3 seconds. Switch legs and repeat. Do 3 sets of 8 repetitions each. Switch positions between sets; watch out for leg cramps.

Leg Extension

As #1 tries to extend leg, #2 resists movement; #2 should allow movement to progress slowly through range of motion in 3 seconds. Switch legs and repeat. Do 3 sets of 8 repetitions each. Switch positions between sets.

Use your imagination to devise additional isokinetic exercises. Isokinetic-type exercise devices are commercially available.

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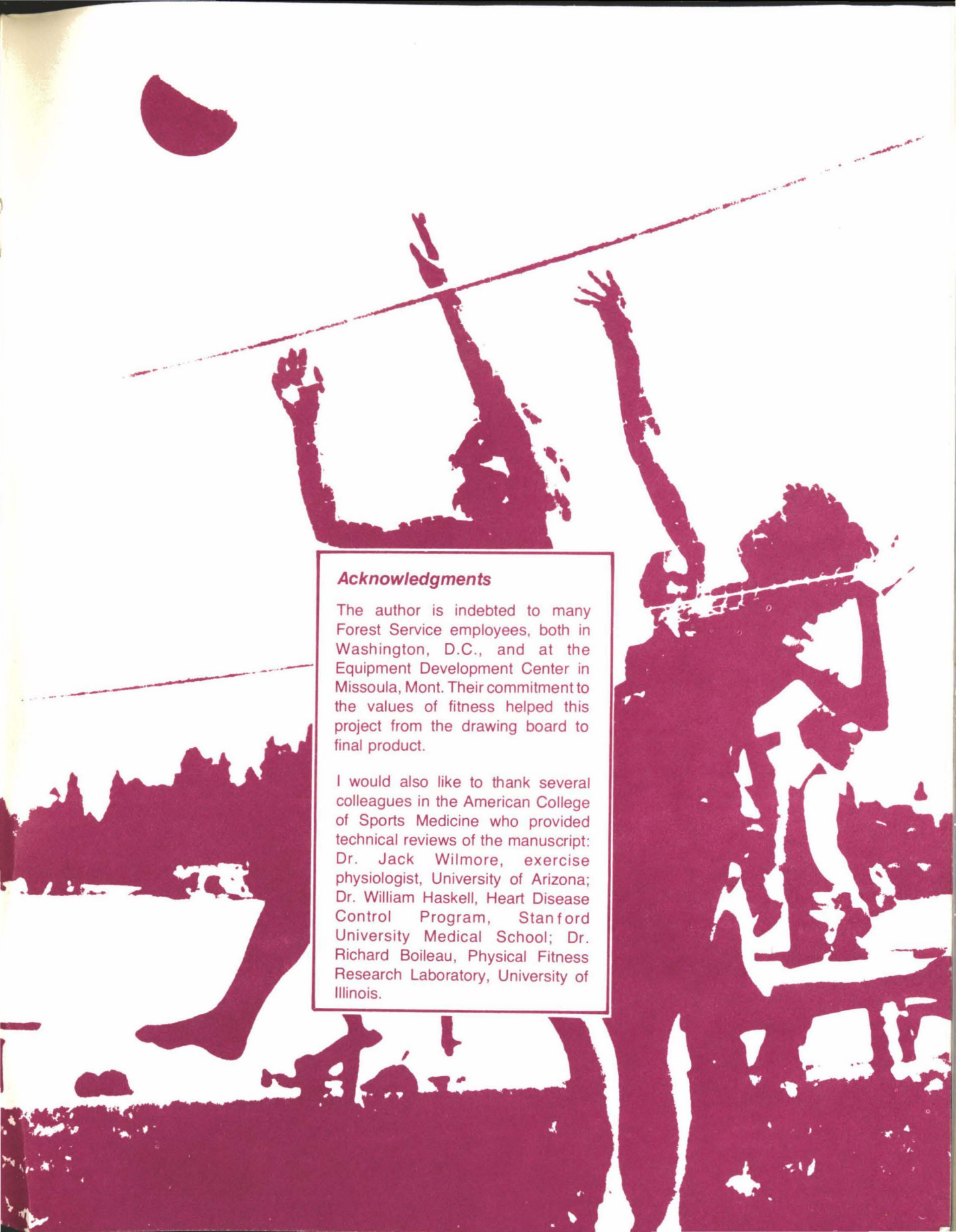

Acknowledgments

The author is indebted to many Forest Service employees, both in Washington, D.C., and at the Equipment Development Center in Missoula, Mont. Their commitment to the values of fitness helped this project from the drawing board to final product.

I would also like to thank several colleagues in the American College of Sports Medicine who provided technical reviews of the manuscript: Dr. Jack Wilmore, exercise physiologist, University of Arizona; Dr. William Haskell, Heart Disease Control Program, Stanford University Medical School; Dr. Richard Boileau, Physical Fitness Research Laboratory, University of Illinois.

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